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U.S. DEPARTMENT OF THE INTERIOR

SELECTED  
 **WATER  
RESOURCES  
ABSTRACTS**



VOLUME 24, NUMBER 2  
FEBRUARY 1991

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GEOLOGICAL SURVEY

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# **SELECTED WATER RESOURCES ABSTRACTS**

A monthly publication of the Geological Survey  
U.S. Department of the Interior

**VOLUME 24, NUMBER 2  
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The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1991.

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## PREFACE

**S**electd Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus**. The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific  
Information Center  
U.S. Geological Survey  
MS 425 National Center  
Reston, VA 22092

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# SELECTED WATER RESOURCES ABSTRACTS

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### 2A. General

#### PHYSICALLY BASED MODEL FOR PREDICTING SOLUTE TRANSFER FROM SOIL SOLUTION TO RAINFALL-INDUCED RUNOFF WATER.

Agricultural Research Service, Riverside, CA. Salinity Lab.  
For primary bibliographic entry see Field 5B.  
W91-01527

#### KINEMATIC CASCADES: DERIVATION OF A GENERALIZED SHOCK FORMATION CRITERION.

Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft.  
For primary bibliographic entry see Field 8B.  
W91-01673

### 2B. Precipitation

#### PRECIPITATION NUTRIENT INPUTS IN SEMIARID ENVIRONMENTS.

Agricultural Research Service, Tucson, AZ. Aridland Watershed Management Research Unit. W. E. Emmerich.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 621-624, July/September 1990. 1 fig, 5 tab, 18 ref.

Descriptors: \*Chemistry of precipitation, \*Nutrient transport, \*Nutrients, \*Precipitation, \*Semi-arid lands, Air masses, Ammonium, Arizona, Nitrates, Nutrient concentrations, Phosphates, Potassium, Seasonal variation, Spatial variation, Storms.

Seasonal and spatial variations in precipitation nutrient inputs were suggested by differences in storm type and air mass origin into southeastern Arizona. Wet precipitation nitrate-N, ammonium-N, phosphate-P, and K inputs were collected at seven sites to determine seasonal and spatial variations in nutrient inputs. Total nutrient inputs and concentrations in summer precipitation were significantly greater than in winter precipitation. Higher total summer inputs and concentrations were attributed to storm type and air mass origin rather than to precipitation amount, as summer precipitation accounted for 56% of the precipitation and 79, 69, 66, and 73% of the nitrate-N, ammonium-N, phosphate-P, and K, respectively. Spatial variability in nutrient input was limited to specific nutrients, seasons, and sites and attributed to precipitation variability and localized sources. Generally, the air masses and storm types that produced seasonal differences in nutrient inputs and concentrations affected all sites uniformly. (Author's abstract)  
W91-01030

#### RAINFALL INDUCED SOIL SEAL (C) A DYNAMIC MODEL WITH KINETIC ENERGY INSTEAD OF CUMULATIVE RAINFALL AS INDEPENDENT VARIABLE.

Hebrew Univ., Rehovoth (Israel). Dept. of Soil and Water Sciences.  
For primary bibliographic entry see Field 2G.  
W91-01089

#### MODIFIED KOEPPEN CLASSIFICATION APPLIED TO MODEL SIMULATIONS OF GLACIAL AND INTERGLACIAL CLIMATES.

Wisconsin Univ.-Madison. Center for Climatic Research.  
P. J. Guetter, and J. E. Kutzbach.  
Climatic Change CLCHDX, Vol. 16, No. 2, p 193-215, April 1990. 7 fig, 3 tab, 41 ref.

Descriptors: \*Atmospheric circulation, \*Classification, \*Climates, \*Climatic changes, \*Climatology, \*Glaciers, \*Global warming, \*Mathematical models, Koeppen classification, Solar radiation.

A series of experiments was done using an atmospheric general circulation model to simulate cli-

mates from full glacial time at 18 ka (thousands of years before the present) to the present at 3000 year intervals, and at 126 ka, the previous interglacial period. A modified Koeppen climate classification was developed to aid in the interpretation of the results of the circulation model experiments. The climate classification scheme permits the characterization of eleven distinct seasonal temperature and precipitation regimes. For the modern climate, the modified classification agrees well with a classification of natural vegetation zones, and provides an easily-assimilated depiction of climate changes resulting from the varying boundary conditions in the past. At 18 ka, the time of glacial maximum, 45% of the land surface had climate classifications different from the present. At 126 ka, a time when northern hemisphere summer radiation was much greater than at present owing to changes in the date of perihelion and tilt of the earth's axis, the corresponding difference was 32%. For all experiments, 3 to 18 ka and 126 ka, only 30% of the land surface showed no change in climate classification from the present. Core areas showing no change included the Amazon basin, the northern Sahara and Australia. (Author's abstract)  
W91-01091

#### CLIMATE AND VEGETATION IN CHINA. III. WATER BALANCE AND DISTRIBUTION OF VEGETATION.

Osaka Univ. (Japan). Faculty of Science.  
For primary bibliographic entry see Field 2I.  
W91-01125

#### ACID RAIN MODEL DEVELOPMENT CONSIDERING ALTITUDINAL PRECIPITATION RATE.

Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea). Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5B.  
W91-01286

#### SEMI-EMPIRICAL APPROACH TO ESTIMATE VERTICAL TRANSPORT BY NONPRECIPITATING CONVECTIVE CLOUDS ON A REGIONAL SCALE.

Research Triangle Inst., Research Triangle Park, NC.  
For primary bibliographic entry see Field 5B.  
W91-01287

#### CHEMISTRY OF DEWS AND FROSTS IN INDIANAPOLIS, INDIANA.

Butler Univ., Indianapolis, IN. Holcomb Research Inst.  
For primary bibliographic entry see Field 5B.  
W91-01288

#### HAILSTONES AS CLOUD WATER COMPOSITION PROBES: AN INITIAL ASSESSMENT.

Washington State Univ., Pullman. Lab. for Atmospheric Research.  
For primary bibliographic entry see Field 2K.  
W91-01289

#### DESIGN FOR AN OCCULT PRECIPITATION COLLECTOR.

Victoria Univ. of Manchester (England). Dept. of Environmental Biology.  
For primary bibliographic entry see Field 7B.  
W91-01291

#### GLOBAL CLIMATE CHANGE: IMPLICATIONS FOR AIR TEMPERATURE AND WATER SUPPLY IN CANADA.

Canadian Climate Centre, Downsview (Ontario). H. G. Hengeveld.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 176-182, March 1990. 3 fig, 1 tab, 33 ref.

Descriptors: \*Air temperature, \*Canada, \*Climatic changes, \*Climatology, \*Global warming, \*Water supply, Air pollution, Aquatic environment, Atmospheric chemistry, Data interpretation, Model

studies, Precipitation, Research priorities, Runoff, Soil moisture.

Results of recent research on changes in atmospheric chemistry and responses of the climate system, with particular focus on those factors important to aquatic ecosystems, are summarized. Measurements of atmospheric concentrations of climatically important gases over the past 30 years indicate a rapid rise in values, largely attributable to human activities. Results of climate model experiments project a major global climate warming of 1.5-4.5 °C during the next century, should the concentrations of these gases continue to increase as predicted. In addition to the direct effects of warming on regional air temperatures and the frequency and severity of extreme heat events, hemispheric wind patterns and hence rainfall distribution will be affected. As a result, soil moisture, runoff, and water supplies to catch basins will change. Such changes have important implications for the nature of future aquatic environments. These projected changes need to be addressed by integrated research, planning, and management. (Author's abstract)  
W91-01388

#### POTENTIAL CHANGES IN THERMAL STRUCTURE AND CYCLE OF LAKE MICHIGAN DUE TO GLOBAL WARMING.

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.  
For primary bibliographic entry see Field 2H.  
W91-01389

#### THERMAL STRUCTURE OF THE LOWER GREAT LAKES IN A WARM YEAR: IMPLICATIONS FOR THE OCCURRENCE OF HYPO-LIMNION ANOXIA.

National Water Research Inst., Burlington (Ontario).  
For primary bibliographic entry see Field 2H.  
W91-01390

#### EFFECTS OF CLIMATE WARMING ON DISSOLVED OXYGEN CONCENTRATIONS IN LAKE ERIE.

HydroQual, Inc., Mahwah, NJ.  
For primary bibliographic entry see Field 2H.  
W91-01391

#### POTENTIAL APPLICATION OF MODELS IN FORECASTING THE EFFECTS OF CLIMATE CHANGES ON FISHERIES.

Oak Ridge National Lab., TN. Environmental Sciences Div.  
D. L. DeAngelis, and R. M. Cushman.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 224-239, March 1990. 5 fig, 2 tab, 38 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: \*Climatic changes, \*Climatology, \*Fisheries, \*Global warming, \*Model studies, Carbon dioxide, Forecasting, Greenhouse effect, Literature review, Mathematical models.

Increased concentrations of carbon dioxide and other 'greenhouse gases' in the atmosphere and the possible resulting climatic changes will affect marine and freshwater fisheries. Many of the links in the causal chains relating these environmental changes to possible changes in fish stocks may be amenable to prediction through mathematical modeling. The adequacy of existing types of mathematical models relating changes in atmospheric CO<sub>2</sub> to changes in environmental conditions and ultimately to changes in fish stocks is reviewed in the context of an overall strategy for forecasting changes in fish stocks. The model types include ecosystem models, fish physiological process models, and fish population models. When integrated with the chain of linkages suggested by envirograms, these models can form a coherent strategy for prediction of future changes. This strategy includes: (1) identification, through modeling and other information, of the causal chains

## Field 2—WATER CYCLE

### Group 2B—Precipitation

likely to be strongest for a variety of important fisheries; (2) a focus of efforts on improving the accuracy of models representing these chains by continuing to refine models through corroboration with appropriate data collected year by year, and an estimation of uncertainties and incorporation of these into models; and (3) by viewing modeling as a means to generate ranges of possible outcomes rather than definite predictions. (White-Reimer-PTT)  
W91-01392

**TEMPERATURE-OXYGEN HABITAT FOR FRESHWATER AND COASTAL STRIPED BASS IN A CHANGING CLIMATE.**  
Oak Ridge National Lab., TN. Environmental Sciences Div.  
C. C. Coutant.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 240-253, March 1990. 7 fig, 55 ref. DOE Contract DE-AC05-84OR21400.

Descriptors: \*Aquatic habitats, \*Climatic changes, \*Climatology, \*Global warming, \*Physicochemical properties, \*Striped bass, Chesapeake Bay, Coastal areas, Dissolved oxygen, Florida, Gulf of Mexico, Gulf of St. Lawrence, Model studies, Temperature effects.

Habitat space for a fish species is normally constrained by extreme temperatures and low dissolved oxygen concentrations that the fish avoid. Both latitudinal limits to a species' geographic distribution and availability of suitable habitat on the local level may be altered by climate change. During the next century, average temperatures are expected to rise globally, and rainfall is expected to decrease in mid latitudes and increase in high latitudes. Some possible effects of climate change on distribution of anadromous and landlocked stocks of striped bass *Morone saxatilis* are predicted. The tenuous existence of striped bass along the northern coast of the Gulf of Mexico and in Florida will likely be jeopardized by regional warming and reduced streamflow. In many freshwater lakes, reservoirs, and estuaries, the existing summer constriction of suitable habitat by high temperatures and low oxygen concentrations may be aggravated by warming, altered streamflow, and increased hypoxia. A major loss of habitat is predicted to occur in the Chesapeake Bay, where the species has had its greatest abundance historically. An expansion of the species' range around Nova Scotia and farther into the Gulf of St. Lawrence may occur, although the cold Labrador Current may increase in volume and cancel any potential water temperature increases in the northernmost range of the species. The understanding of the habitat requirements of many commercially and recreationally important fish species exceeds the confidence in climate models, but will allow forecasts of changes in regional and local habitat suitability as the understanding of climate and the ability to forecast it improve. (Author's abstract)  
W91-01393

**POTENTIAL CHANGES IN THE THERMAL HABITAT OF GREAT LAKES FISH AFTER GLOBAL CLIMATE WARMING.**  
Wisconsin Univ.-Madison. Center for Limnology. J. J. Magnuson, J. D. Meisner, and D. K. Hill.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 254-264, March 1990. 3 fig, 2 tab, 38 ref. National Sea Grant College Program and state of Washington federal grant NA800-AA-D-0086, project R/GB-28.

Descriptors: \*Aquatic habitats, \*Climatic changes, \*Climatology, \*Fisheries, \*Global warming, \*Great Lakes, \*Limnology, \*Temperature effects, Anoxic conditions, Black bass, Fish populations, Lake Erie, Lake Michigan, Model studies, Perch, Pikeperch, Salmon, Thermal stratification, Trout, Whitefish.

The potential changes in the size of thermal habitat of representative cold-, cool-, and warmwater fish were estimated for southern Lake Michigan and the central basin of Lake Erie before and after simulated global warming. Observed midlake ther-

mal structures were modeled (BASE) and then manipulated with three general circulation climate models (OSU, GISS, GFDL) that projected warmer climates when atmospheric carbon dioxide concentrations were doubled. Under BASE conditions, on an annual basis, lake trout *Salvelinus namaycush* had the largest thermal habitat in southern Lake Michigan, coho salmon *Oncorhynchus kisutch* and yellow perch *Perca flavescens* had smaller thermal habitats, and largemouth bass *Micropterus salmoides* had none. Even for lake trout, the suitable thermal habitat was only 5-20% of the upper 200 m through the year. With rare exceptions, thermal habitat increased for species in all thermal guilds for all climate-warming scenarios. No thermal habitat was estimated for coldwater fish in the central basin of Lake Erie because the hypolimnion becomes anoxic in summer. The median increase in thermal habitat was 2.5 x BASE condition both for southern Lake Michigan and the central basin of Lake Erie. After climate warming, minimum thermal habitat during summer decreased for walleye *Stizostedion vitreum*, increased for yellow perch, and remained the same for lake whitefish *Coregonus clupeaformis* and lake trout. Fish yields estimated from published empirical models that relate thermal habitat in summer to maximum sustained yields remained about the same for lake trout and lake whitefish but increased for walleye. It was concluded that the sizes of the habitat favorable for cold-, cool-, and warmwater fish would increase in Lake Michigan, whereas the habitats favorable only for cool- and warm water fish would increase in Lake Erie. (Author's abstract)  
W91-01394

**POTENTIAL EFFECTS OF GLOBAL CLIMATE WARMING ON THE GROWTH AND PREY CONSUMPTION OF GREAT LAKES FISH.**  
Wisconsin Univ.-Madison. Center for Limnology. D. K. Hill, and J. J. Magnuson.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 265-275, March 1990. 5 fig, 1 tab, 34 ref. National Sea Grant College Program and state of Wisconsin federal grant NA800AA-D-0086.

Descriptors: \*Climatic changes, \*Climatology, \*Fish growth, \*Fish populations, \*Food chains, \*Global warming, \*Great Lakes, \*Limnology, \*Temperature effects, Bioenergetics, Model studies, Predation, Prey, Seasonal variation, Thermoregulation.

Fish bioenergetics models were used to assess the effect of global climate warming on the growth and prey consumption of warm-, cool-, and coldwater fishes at three sites spanning the range of thermal environments in the Great Lakes. Historical air and water temperature data and projected air temperature changes from three global climate models were used as input to regression models, which generated projections of water temperature changes before and after climate warming that would result from a doubling in atmospheric CO<sub>2</sub> concentration. The bioenergetics simulations indicated that annual growth by yearling fish would increase with climate warming if prey consumption increased, but would decrease if prey consumption was constant. Changes in growth would be most pronounced in spring and autumn owing to a lengthening of the period during which fishes may behaviorally thermoregulate to find their optimal temperature for growth. Fish unable to thermoregulate (e.g. due to hypolimnetic oxygen depletion) would undergo decreased growth or weight loss in summer in warmer areas of the Great Lakes, where near-surface water temperatures would increase above the fishes' optimum. It was concluded that the food web dynamics and the potential for thermoregulation will greatly influence the direction and magnitude of changes in fish growth as the climate warms. (Author's abstract)  
W91-01395

**EFFECT OF AIR TEMPERATURE ON GROWTH OF LARGEMOUTH BASS IN NORTH AMERICA.**  
Wilfrid Laurier Univ., Waterloo (Ontario). Dept. of Biology.

For primary bibliographic entry see Field 2H.  
W91-01396

**POTENTIAL LOSS OF THERMAL HABITAT FOR BROOK TROUT, DUE TO CLIMATIC WARMING, IN TWO SOUTHERN ONTARIO STREAMS.**  
Toronto Univ. (Ontario). Dept. of Zoology.  
For primary bibliographic entry see Field 81.  
W91-01397

**SEA LAMPREY AS AN EARLY RESPONDER TO CLIMATE CHANGE IN THE GREAT LAKES BASIN.**  
Toronto Univ. (Ontario). Dept. of Zoology.  
J. A. Holmes.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 292-300, March 1990. 2 fig, 2 tab, 49 ref. Natural Sciences and Engineering Research Council of Canada Operating Grant OGP0003918.

Descriptors: \*Bioindicators, \*Climatic changes, \*Climatology, \*Global warming, \*Great Lakes Basin, \*Lamprey, \*Limnology, Conductivity, Egg incubation, Forecasting, Growth, Model studies, Regression analysis, Temperature effects.

Forecasts based on initial assessments of climate change and its consequences for aquatic ecosystems are unlikely to be taken seriously unless some evidence becomes available that the forecasted effects are occurring. Many population rate processes should respond early to temperature and these responses may be used to detect some of the ecological effects of climate warming early in the process of change. In the Great Lakes basin, larval sea lampreys *Petromyzon marinus* and other stream fish may be such indicators. The hypothesis that temperature exerts a significant influence on two rate processes of sea lamprey, egg hatching and larval growth rate were tested by regression analysis using the Arrhenius model. The length of egg incubation was significantly related to the proportion of eggs hatching and to temperature ( $P < 0.01$ ); temperature accounted for 88% of the total variability in hatching time. Both temperature and conductivity (as surrogate measure of stream productivity) were significant ( $P < 0.01$ ) univariate predictors of growth rate in larval sea lamprey populations subjected to repeated lampricide treatments. However, temperature was the better predictor of growth ( $r^2 = 0.56$ ) and the conductivity variable did not contribute significantly ( $P > 0.15$ ) in a stepwise multiple regression. Forecasts can be based on these temperature relationships which can be tested if and when climate change occurs. (Author's abstract)  
W91-01398

**SIZE-DEPENDENT WINTER MORTALITY OF YOUNG-OF-THE-YEAR WHITE PERCH: CLIMATE WARMING AND INVASION OF THE LAURENTIAN GREAT LAKES.**  
York Univ., Toronto (Ontario). Dept. of Biology.  
For primary bibliographic entry see Field 81.  
W91-01399

**CLIMATE, POPULATION VIABILITY, AND THE ZOOGEOGRAPHY OF TEMPERATE FISHES.**  
Ontario Ministry of Natural Resources, Maple. Fisheries Branch.  
B. J. Shuter, and J. R. Post.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 314-336, March 1990. 15 fig, 5 tab, 72 ref, append.

Descriptors: \*Climatic changes, \*Climatic effects, \*Climatology, \*Fish populations, \*Population dynamics, \*Zoogeography, Age classes, Black bass, Distribution, Fish behavior, Global warming, Perch, Seasonal variation, Starvation, Thermal effects.

The feeding activity of warmwater and coolwater fishes can be severely restricted during the long period of cold temperatures characteristic of

winter in temperate zone lakes and rivers. The effect of such restriction is greater for smaller fish. Weight-specific basal metabolism increases as size decreases; however, there is no corresponding increase in energy storage capacity. Thus, smaller fish tend to be less tolerant of starvation conditions because they exhaust their energy stores sooner. Such size dependence of starvation endurance has often been observed in laboratory experiments. In wild populations commonly subject to winter starvation, population viability hinges on the ability of young-of-the-year to complete a minimum amount of growth during their first year of life. From south to north, this ability is increasingly restricted as the growing season shortens and the starvation period lengthens. It is shown that this constraint is sufficient to explain the present locations of the northern distributional limit for yellow perch *Perca flavescens* in central and western North America, the northern distributional limit for Eurasian perch *P. fluviatilis* in Eurasia, and the northern distributional limit for smallmouth bass *Micropterus dolomieu* in central North America. Shifts in North American climate may relax this constraint and permit both yellow perch and smallmouth bass to thrive well to the north of their present distributions. (Author's abstract)

W91-01400

#### CLIMATE CHANGE AND FISH COMMUNITIES: A CONCEPTUAL FRAMEWORK.

Alberta Univ., Edmonton. Dept. of Zoology.  
For primary bibliographic entry see Field 81.  
W91-01401

#### IMPLICATIONS OF CLIMATE CHANGE FOR FISHERIES MANAGEMENT POLICY.

Department of Fisheries and Oceans, Nanaimo (British Columbia). Pacific Biological Station.  
For primary bibliographic entry see Field 81.  
W91-01402

#### INFLUENCE OF TEMPERATURE CHANGES ON AQUATIC ECOSYSTEMS: AN INTERPRETATION OF EMPIRICAL DATA.

Toronto Univ. (Ontario). Dept. of Zoology.  
H. A. Regier, J. A. Holmes, and D. Pauly.  
Transactions of the American Fisheries Society  
TAFSAI, Vol. 119, No. 2, p. 374-389, March 1990.  
12 fig. 3 tab. 66 ref. Natural Sciences and Engineering Research Council of Canada Grant OGP0003918.

Descriptors: \*Aquatic organisms, \*Climatic changes, \*Climatology, \*Data interpretation, \*Ecosystems, \*Limnology, \*Temperature effects, Adaptation, Exponential models, Global warming, Model studies, Physicochemical properties, Temperature.

Many mathematical relationships have been used to summarize quantitative information about the effects of temperature on rate processes in ectothermic living systems. One of the more common relationships, which has been used for a century is termed the 'combined exponential model.' An exponential model, as with a first-order chemical reaction, is used to define a coefficient for a rate at a particular temperature; another exponential relationship (of the van't Hoff or the Arrhenius form) is then used to relate the coefficients of the rate process to their respective temperatures. The Arrhenius form has come to be preferred over the van't Hoff form. In ectotherm physiology, the combined exponential model applies when the relevant organism has not evolved means of compensating biologically for the underlying physicochemical dynamics as affected by temperature. The applicability of the combined model, of the Arrhenius form, to analogous ecological situations for aquatic ectothermic populations and ecosystems was assessed. On an empirical basis, it was found that this combined model has some utility in that it permits approximate assessments of some ecosystemic effects of climate warming. Aquatic ecosystems of temperate waters or that are dominated by ectothermic r-type species appear to possess relatively little self-organizing capability to compensate for climate warming. As with other living systems at lower 'levels of organization' that have

not evolved internal ways to temper external temperature fluctuations, certain ecosystem processes may adapt to climate warming approximately as indicated by the combined exponential model. (Author's abstract)

W91-01403

#### DRY DEPOSITION OF SULFUR: A 23-YEAR RECORD FOR THE HUBBARD BROOK FOREST ECOSYSTEM.

New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies.  
For primary bibliographic entry see Field 5B.  
W91-01411

#### RELATIONSHIP BETWEEN CANADIAN PRAIRIE DRY AND WET MONTHS AND CIRCULATION ANOMALIES IN THE MID-TROPOSPHERE.

J. L. Knox, and R. G. Lawford.  
Atmosphere - Ocean ATOCDA, Vol. 28, No. 2, p. 189-215, June 1990. 11 fig. 5 tab. 24 ref. 2 append.

Descriptors: \*Atmospheric circulation, \*Canada, \*Climatology, \*Prairies, \*Precipitation, Areal precipitation, Atmospheric physics, Atmospheric water, Climatic changes, Climatic zones, Data analysis, Model studies, Precipitation mapping, United States.

The dry and wet months for the Canadian prairies during the 40-year period 1946-1985 were identified and the relationship to the Northern Hemisphere circulation at the 50-kPa and 100-kPa levels is investigated. The target area is first subdivided into five zones on the basis of characteristic differences in precipitation climatology, and for each zone the dates of occurrence of dry and wet months are determined. These events are then stratified into five 'seasons'. Much of the analysis focuses on the two growing seasons: spring, defined as April and May, and early summer, June and July. Composite anomaly fields for the Northern Hemisphere are constructed for the 50-kPa level by 'season' and zone, and for the dry and wet groupings. For each zone, the two 50-kPa anomaly fields dry and wet are clearly distinguishable, not only over North America but in many instances, upstream and downstream of the continent. Composite anomalies are shown to be zone-sensitive. The 100-kPa and 50-kPa anomalous wind fields associated with the dry and wet regimes, respectively, are found to be consistent with dynamic and thermodynamic processes that control the production of precipitation. Anomaly field structures over the oceans and North America are related to Northern Hemisphere tropospheric circulation modes, including the Pacific-North Atlantic pattern, and the North Pacific and North Atlantic oscillations. High-latitude blocking over the North Atlantic and North Pacific is often associated with wet months, particularly in spring, whereas 'in situ' blocking over western Canada or simply amplified ridging extending northward from the western United States is almost invariably associated with dry months. (Author's abstract)

W91-01429

#### RADAR OBSERVATIONS OF PRECIPITATION PRODUCTION IN THUNDERSTORMS.

McGill Univ., Montreal (Quebec). Dept. of Meteorology.  
G. W. Reuter.  
Atmosphere - Ocean ATOCDA, Vol. 28, No. 2, p. 216-229, June 1990. 6 fig. 4 tab. 24 ref.

Descriptors: \*Meteorology, \*Precipitation, \*Radar, \*Rainstorms, \*Thunderstorms, Atmospheric physics, Atmospheric water, Local precipitation, Mathematical analysis, Mathematical equations, Rainfall intensity, Rainfall rate, South Africa.

Little is known about the magnitudes and temporal behavior of integrated storm parameters for thunderstorms in regions outside North America. Precipitation production was investigated for 9 intense thunderstorms that developed over the Lowveld in South Africa. A C-band radar was used to observe the 3-dimensional reflectivity pattern of the storms.

Using an empirical relation between reflectivity factor and precipitation content and integrating over the storm volume provides an estimate of the total precipitation content aloft. Likewise, an area integration of the instantaneous rain rate at cloud base yields an estimate of the rate of total outflow. At their maturing stage, the storms had precipitation contents of 0.2 to 5.0 Tg and rainfall rates of about 0.3 to 2.0 Gg/s. The total accumulation of rain at the ground ranged from 1 to 10 Tg. The characteristic storm updraft, defined as the ratio of the area-averaged rainfall rate to the volume-averaged precipitation content, was about 5 m/s for all storms. The time evolution of integral storm parameters is also presented and related to the overall storm development. The precipitation production values observed in the Lowveld storms compares well with previous estimates reported for large thunderstorms observed in Alberta and New England. (Author's abstract)

W91-01430

#### RELEVANCE OF THE MICROPHYSICAL AND RADIATIVE PROPERTIES OF CIRRUS CLOUDS TO CLIMATE AND CLIMATIC FEEDBACK.

Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.  
G. L. Stephens, S. C. Tsay, P. W. Stackhouse, and P. J. Flatau.

Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 14, p. 1742-1753, July 15, 1990. 8 fig. 1 tab. 30 ref. append. NSF Contract ATM-8812353 and USAF Contract AFOSR-88-0143.

Descriptors: \*Air temperature, \*Climatology, \*Cloud physics, \*Ice, \*Radiation, Albedo, Atmospheric physics, Atmospheric water, Carbon dioxide, Climatic changes, Data analysis, Global warming, Mathematical analysis, Mathematical models, Model studies, Physical properties, Radar.

The effects of the relationship between cirrus cloud ice water content and cloud temperature on climate change are examined. A simple mechanistic climate model is used to study the feedback between ice water content and temperature. The central question studied concerns the extent to which both the radiative and microphysical properties of cirrus cloud influence such a feedback. To address this question, a parameterization of the albedo and emissivity of clouds is introduced. Observations that relate the ice water content to cloud temperature are incorporated in the parameterization to introduce a temperature dependence to both albedo and emittance. The cloud properties relevant to the cloud feedback are expressed as functions of particle size, asymmetry parameter  $g$  and cloud temperature and analyses of aircraft measurements, lidar and ground based radiometer data are used to select  $g$  and  $g$ . Scattering calculations assuming spherical particles with a distribution described by  $re = 16$  microns reasonably matched the lidar and radiometer data. However, comparison of cloud radiation properties measured from aircraft to those parameterized in this study required values of  $g$  significantly smaller than those derived for spheres but consistent with our understanding of nonspherical particle scattering. The climate simulations revealed that the influence of cirrus cloud on climate was strongly affected by the choice of  $re$  and  $g$ : parameters that are both poorly known for cirrus. The effect of ice water feedback on a CO<sub>2</sub> warming simulation could be either positive or negative depending on the value of  $re$  assumed. Based on these results, it was concluded that prediction of cirrus cloud feedback on climate is both premature and limited by our lack of understanding of the relationship between size and shape of ice crystals and the gross radiative properties of cirrus. (Author's abstract)

W91-01445

#### TIME SCALES AND VARIABILITY OF AREA-AVERAGED TROPICAL OCEANIC RAINFALL.

Texas A and M Univ., College Station. Dept. of Meteorology.  
K. S. Shin, G. R. North, Y. S. Ahn, and P. A. Arkin.

Monthly Weather Review MWREAB, Vol. 118,

## Field 2—WATER CYCLE

### Group 2B—Precipitation

No. 7, p 1507-1516, July 1990. 7 fig, 24 ref. NOAA Grant NA87AA-D-CC118 and NASA Grant NAG5-868.

Descriptors: \*Marine climates, \*Meteorology, \*Pacific Ocean, \*Rainfall distribution, \*Statistical analysis, \*Tropical regions, Analysis of variance, Convection, Correlation analysis, Data interpretation, Diurnal variation, Mathematical analysis, Meteorological data, Satellite technology, Tropic zone, Variability.

A statistical analysis of time series of area-averaged rainfall over the oceans has been conducted around the diurnal time scale. The results of this analysis can be applied directly to the problem of establishing the magnitude of expected errors to be incurred in the estimation of monthly area-averaged rain rates from low orbiting satellites. Such statistics as the mean, standard deviation, integral time scale of background red noise and spectral analyses were performed on time series of the GOES Precipitation Index (GPI) taken at 3-hour intervals during the period spanning December 19, 1987 to March 31, 1988 over the central and eastern tropical Pacific. The analyses have been conducted on 2.5 degree x 2.5 degree and 5 degree x 5 degree grid boxes, separately. The ratio of standard deviation to mean for area-averaged rain rate in the Pacific ITCZ is very regular and similar to that in GATE. Analysis of the area-averaged rainfall in the SPCZ shows a longer autocorrelation time scale than that in the ITCZ. The SPCZ exhibits significant power at the diurnal and semidiurnal frequencies, but the ITCZ shows only a marginally significant diurnal cycle in the data. The rainfall characteristics in the Pacific ITCZ appear to be similar to those in the Atlantic ITCZ in both autocorrelation time scale and diurnal variation. The mechanism driving convection in the ITCZ is suggested to be different from that in the SPCZ. Rainfall measurements by a sun-synchronous satellite visiting a spot twice per day will include a bias due to the existence of semidiurnal cycle in the SPCZ ranging from 5 to 10 percentage points. The bias in the ITCZ may be of the order of 5 percentage points. (Author's abstract) W91-01446

#### CHEMICAL COMPOSITION AND ACIDITY OF RAINFALL IN THE ALLIGATOR RIVERS REGION, NORTHERN TERRITORY, AUSTRALIA.

Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia). For primary bibliographic entry see Field 5B. W91-01449

#### SPATIAL VARIABILITY OF ANNUAL PRECIPITATION AND ENSO EVENTS IN WESTERN PERU.

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering. T. D. Tapley, and P. R. Waylen. Hydrological Sciences Journal HSDJODN, Vol. 35, No. 4, p 429-446, August 1990. 10 fig, 6 tab, 20 ref. NSF Grant SES 8713738.

Descriptors: \*Annual precipitation, \*Climatology, \*El Nino/Southern Oscillation, \*Hydrologic models, \*Model studies, \*Peru, \*Rainfall distribution, Areal precipitation, Drought, Rainfall, Spatial distribution, Stochastic hydrology.

The El Nino-Southern Oscillation (ENSO) phenomenon has been the focus of many diverse investigations since the mid 1960s. It is well known that the ENSO brings anomalously high precipitation to the northern coast of Peru. The probability distributions of annual rainfall totals at 18 stations from the north coast of Peru to the southern highlands and Altiplano were analyzed. It was found that most stations exhibit high interannual variability which cannot be satisfactorily modeled by a single lognormal distribution. Indices of the ENSO identified two precipitation regimes: the ENSO regime and the non-ENSO regime. Simple descriptive statistics of rainfalls within the two sub-samples indicate that during ENSO years the Altiplano and southern highland regions experience drought, with an average reduction in mean annual precipi-

tation of 18%, while the north coastal region receives over 88% above non-ENSO rainfall. A mixed lognormal model of annual precipitation was successfully fitted to all stations. The estimated parameters reflect the contrasting response of the two regions to ENSO events. Pearson product-moment correlation matrices generated between stations for each sub-sample further support the hypothesized negative relationship between conditions on the northern coast and the Altiplano. The resulting model describes the stochastic nature of annual precipitation in the area and illustrates regional differences in the influence of ENSO. (Author's abstract) W91-01463

#### DECADAL-SCALE CHANGES OF THE CIRCULATION IN THE TROPICAL ATLANTIC SECTOR ASSOCIATED WITH SAHEL DROUGHT.

Wisconsin Univ.-Madison. Dept. of Meteorology. S. Hastenrath. International Journal of Climatology IJCLEU, Vol. 10, No. 5, p 459-472, July/August 1990. 7 fig, 1 tab, 24 ref. NSF Grant ATM-8722410; NOAA Grant NA86AA-D-AC064.

Descriptors: \*Atmospheric circulation, \*Climatic changes, \*Climatology, \*Drought effects, \*Tropical regions, Africa, Air temperature, Arid climates, Atmospheric pressure, Clouds, Coasts, Drought, Sahara Desert, Wind.

Trends in the general circulation setting during 1948-1983 accompanying the progressive aggravation of drought in sub-Saharan Africa were investigated from ship observations over the tropical Atlantic and surface station records in western Africa. Decadal-scale circulation changes in the Atlantic sector include a pressure rise over the tropical North Atlantic; southward displacement of the near-equatorial wind confluence and associated maximum cloud belt; acceleration of the northeast trades and possibly a strengthening of the South Atlantic trades, along with increasing cloudiness in the equatorial zone; increasing cloudiness over the tropical North Atlantic and Central American seas; and cooling of surface waters in a band across the tropical North Atlantic contrasting with warming in the South Atlantic. These changes occurred in all seasons, but were most pronounced at the height of boreal summer. Records at land stations in western Africa show that near the coasts the temperature and pressure trends are consistent with the adjacent ocean areas. In the interior of sub-Saharan Africa, warming trends prevail in boreal summer, with concomitant downward pressure trends. During the past four decades, the near-equatorial wind confluence over the eastern Atlantic migrated southward by 200 km in July-August and 150 km for the rainy season as a whole. These circulation shifts are large enough to account for the observed downward trend in Sahel rainfall. (Author's abstract) W91-01465

#### REGIONALIZATION AND SPATIAL ESTIMATION OF ETHIOPIAN MEAN ANNUAL RAINFALL.

Lund Univ. (Sweden). Dept. of Physical Geography. L. Eklundh, and P. Pilesjö. International Journal of Climatology IJCLEU, Vol. 10, No. 5, p 473-494, July/August 1990. 21 fig, 7 tab, 19 ref.

Descriptors: \*Annual precipitation, \*Climatic data, \*Climatology, \*Data interpretation, \*Ethiopia, \*Rainfall distribution, Climatic zones, Dispersion, Factor analysis, Model studies, Model testing, Precipitation mapping, Principal component analysis, Rainfall, Regression analysis, Spatial distribution.

A need has been recognized for developing methods that will lead to the generation of a reliable mean annual precipitation database for Ethiopia. Multiple regression models have been formulated that explain the mean annual rainfall as a function of elevation and geographical location. The estimations, based on yearly values from a data set of 63 Ethiopian rainfall stations with records between

1969 and 1985, were developed for the whole country as well as for the already existing Food and Agricultural Organization (FAO) rainfall pattern regions, and a new zonation derived by principal component and common factor analyses (PCA/CFA). The optimal zonation was derived by testing 36 different combinations resulting in different rainfall pattern regions. The alternatives tested were: correlation and covariance dispersion matrices, PCA and CFA eigentechniques, unrotated and rotated components/factors and number of possible significant components/factors. Principal component analysis of covariance matrix, rotation and seven extracted components gave by far the best relationship between mean annual rainfall, elevation, and geographical location. Models explaining at least 72 percent of the variation in rainfall were constructed for regions covering about 98 percent of the country, which is better than models based on the FAO rainfall pattern regions and a model for the whole country. (Author's abstract) W91-01466

#### TEMPORAL AND SPATIAL CHARACTERISTICS OF ANNUAL PRECIPITATION OVER THE BALKANS IN THE TWENTIETH CENTURY.

Thessaloniki Univ., Salonika (Greece). Inst. of Meteorology and Climatology. P. Maheras, and F. Kolyva-Machera. International Journal of Climatology IJCLEU, Vol. 10, No. 5, p 495-504, July/August 1990. 4 fig, 3 tab, 23 ref.

Descriptors: \*Annual precipitation, \*Balkans, \*Climatology, \*Mediterranean Sea, \*Rainfall distribution, \*Temporal distribution, Atmospheric circulation, Drought, Principal component analysis, Spatial distribution, Statistical analysis.

There has been great interest recently in fluctuations in precipitation the past century for western and central Europe and for the western Mediterranean. The annual totals of precipitation were studied for 12 stations in the Balkan area for a period of 92 years (1894-1985). The homogeneity of the precipitation series and their statistical characteristics were analyzed. An abrupt climatic change was found at the station of Belgrad, and a statistically significant trend of annual precipitation was found for various periods at the stations of Kerkira, Patras, Hvar, and Sarajevo. Persistence was ascertained only for the Belgrad station. The application of principal component analysis yielded three groups of stations. Group A includes northern and continental stations, group B includes stations of the Ionian and Adriatic Seas, and group C includes the stations of Thessaloniki and Athens. The most important period of fluctuations covers the years 1933-1953, when a humid period was followed by a dry period. The most recent 5-year period was a very dry one. Finally, comparisons between rainfall fluctuations and types of circulation show that the predominance of meridional circulation over the Balkans results in an increase of precipitation, while a zonal circulation results in a decrease of precipitation. (Author's abstract) W91-01467

#### RAIN SCAVENGING OF TEPHRA AEROSOLS FROM MOUNT ST. HELENS 1980 ERUPTIONS.

Arkansas Univ., Fayetteville. Dept. of Geology. G. H. Wagner, and K. E. Steele. Journal of Applied Meteorology JAMOAX, Vol. 29, No. 5, p 368-374, 1990. 1 fig, 4 tab, 11 ref.

Descriptors: \*Ash, \*Mineralogy, \*Precipitation scavenging, \*Tephra, \*Volcanoes, Aerosols, Atmospheric circulation, Clay minerals, Illite, Kaolinite, Meteorological data, Mount St Helens, Particulate matter, Quartz, Rainfall disposition, Washington.

Mount St. Helens in southern Washington state had three major eruptions in 1980: 18 May, 25 May, and 12 June. Tephra in the atmosphere from these eruptions was traced by analyzing the particulate matter from weekly rain collections at 62 National Atmospheric Deposition Program sites

across the United States. The particulate matter was on 0.45 micron pore-sized filters (47 mm diameter) in amounts of 0-214 mg. Identification of tephra in the particulate matter was made by x-ray diffraction, identification of feldspar (70% of the tephra), and chemical analyses compared to a standard tephra. Tephra was identified at sites in the path defined by observable amounts on the ground and outside and beyond this path. Dilution of the tephra by other aerosols varied from 20% near Mount St. Helens to about 300% at downwind sites, which were two days and 3000 km from Mount St. Helens. Atmospheric cleanup of the tephra at a given site occurred in 1-2 weeks, sometimes in a few days, as measured by the particulate matter in rain. Particulate matter captured in rains before the eruptions was mainly alpha quartz, feldspar, illite, kaolinite and organics with an average flux for the United States of 112 kg per ha per week. (Author's abstract)  
W91-01468

**META-ANALYTIC REAPPRAISAL OF STATISTICAL RESULTS IN THE ENVIRONMENTAL SCIENCES: THE CASE OF A HYDROLOGICAL EFFECT OF CLOUD SEEDING.**  
Hebrew Univ. of Jerusalem (Israel). Inst. of Earth Sciences.  
For primary bibliographic entry see Field 3B.  
W91-01470

**FURTHER EXPLORATORY EVALUATIONS OF GROSSVERSUCH IV USING HAILPAD DATA: ANALYSIS OF HAIL PATTERNS AND STRATIFICATION BY STORM TYPE FOR SEEDING EFFECT.**  
Groupe National d'Etudes des Fleaux Atmosphériques, Aubière, France.  
J. F. Mezeix.  
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 5, p 401-417, 1990. 7 fig, 9 tab, 28 ref, append.

Descriptors: \*Cloud seeding, \*Data interpretation, \*Hail, \*Hydrologic models, \*Meteorological data, \*Soviet Union, \*Storms, Areal precipitation, Distribution patterns, France, Italy, Model studies, Precipitation mapping, Spatial distribution, Switzerland.

In the Grossversuch IV experiment, scientific groups from three countries (Switzerland, Italy, and France) worked together to test the Soviet hail suppression method, based on the concept of beneficial competition of hailstone embryos. Further exploratory evaluations were made of the hail suppression experiment using the spatial distribution of ground-measured variables within hail patterns. The possibility of a seeding effect limited to a part of a hailfall or to various objectively stratified types of precipitation cells was investigated. The results show an increase in the ratio of the hail areas with maximum hailstone diameters greater than 10 mm versus the total hail area, and an increase in the maximum hailstone diameter for type II repetitive evolution cells. Differences observed for the main test variables in relation to the various cell types were shown to largely exceed those that could stem from a possible seeding effect. A satisfactory physical interpretation of the differential tendency related to the storm type is impossible, however, because the simple storm model on which the Grossversuch IV experiment is not based on three-dimensional storm measurements. Future test experiments should be based on several test variables characteristic of the overall hailfall phenomenon and especially of the area factor. In addition, storms should be physically stratified in an objective manner. (Author's abstract)  
W91-01471

**DETERMINATION FROM SPACE OF ATMOSPHERIC TOTAL WATER VAPOR AMOUNTS BY DIFFERENTIAL ABSORPTION NEAR 940 NM: THEORY AND AIRBORNE VERIFICATION.**  
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. d'Optique Atmosphérique.  
For primary bibliographic entry see Field 7B.

W91-01472

**PERSISTENCE OF SEEDING EFFECTS IN A WINTER OROGRAPHIC CLOUD SEEDING WITH SILVER IODIDE BURNED IN ACETONE.**

Bureau of Reclamation, Auburn, CA.  
For primary bibliographic entry see Field 3B.  
W91-01473

**ALGORITHM FOR RETRIEVING WATER VAPOR PROFILES IN CLEAR AND CLOUDY ATMOSPHERES FROM 183 GHZ RADIOMETRIC MEASUREMENTS: SIMULATION STUDIES.**

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.  
For primary bibliographic entry see Field 7C.  
W91-01474

**THUNDERSTORMS ABOVE FRONTAL SURFACES IN ENVIRONMENTS WITHOUT POSITIVE CAPE. PART I: A CLIMATOLOGY.**  
National Oceanic and Atmospheric Administration, Boulder, CO. Environmental Research Labs. B. R. Colman.  
Monthly Weather Review MWREAB, Vol. 118, No. 5, p 1103-1121, 1990. 19 fig, 21 ref. NSF Grant ATM-8019301.

Descriptors: \*Climatology, \*Convective precipitation, \*Meteorology, \*Thunderstorms, \*Weather patterns, Advection, Atmospheric circulation, Atmospheric pressure, Climatic data, Convection, Frequency distribution, Meteorological data collection, Wind.

Thunderstorms occur frequently above frontal surfaces in environments without positive convective available potential energy (CAPE). The climatology of such storms were studied for the conterminous United States using a dataset consisting of 1093 observations made over a 4-year period. A composite of the dataset shows that the typical 'elevated' thunderstorm occurs northeast of an associated surface low pressure center, and north of a surface warm front in a region with northeasterly surface winds. The planetary boundary layer is generally very stable. The thunderstorms are usually found in the left exit region of a low-level wind maximum. The large-scale environment is strongly baroclinic with large vertical wind shear and warm advection. Several of the identified characteristics suggest that frequently elevated thunderstorms are the result of physical mechanisms different from those fundamental to surface-based thunderstorms, e.g., for elevated thunderstorms there is generally very little positive CAPE in the environment, as the atmosphere is slightly more stable than moist adiabatic above the frontal inversion. The annual frequency distribution of elevated thunderstorms is bimodal, with a primary peak in April and a secondary peak in September. The events are concentrated in an area extending northward from the central Gulf Coast along the Mississippi River valley. Nearly all winter season thunderstorms east of the Rocky Mountains are of the elevated type, except those over the Florida Peninsula, where surface-based convection persists throughout the year. Most of the winter season elevated thunderstorms occur near the Gulf Coast downstream from migrating cyclones. (See also W91-01482) (Author's abstract)  
W91-01481

**THUNDERSTORMS ABOVE FRONTAL SURFACES IN ENVIRONMENTS WITHOUT POSITIVE CAPE. PART II: ORGANIZATION AND INSTABILITY MECHANISMS.**  
National Oceanic and Atmospheric Administration, Boulder, CO. Environmental Research Labs. B. R. Colman.  
Monthly Weather Review MWREAB, Vol. 118, No. 5, p 1123-1144, 1990. 33 fig, 17 ref. NSF Grant ATM-8019301.

Descriptors: \*Climatology, \*Convective precipitation, \*Meteorology, \*Thunderstorms, \*Weather patterns, Air temperature, Atmospheric circulation, Boundary layers, Convection, Hydrostatic pressure, Meteorological data collection, Temperature effects, Thermodynamics.

tion, Boundary layers, Convection, Hydrostatic pressure, Meteorological data collection, Temperature effects, Thermodynamics.

Thunderstorms occur above frontal surfaces frequently in environments without positive convective available potential energy (CAPE). An impressive outbreak of elevated thunderstorms during the Atmospheric Variability Experiment- Severe Environmental Storms and Mesoscale Experiment were studied. The thunderstorms occurred in three convective impulses, each of which developed in a warm sector before propagating onto the frontal surface; subsequent thunderstorms developed over the frontal surface. While in the warm sector, the convection was supported by an extremely unstable boundary layer. However, this convective energy quickly diminished above the frontal surface and thunderstorms continued and developed for many hours in an essentially stable hydrostatic environment. During the lifetime of these impulses, mesoscale updrafts developed and moved with the convective areas, maintaining nearly steady-state systems with strong low-level inflow. The environment was found to be symmetrically neutral in the region of the inflow. Numerous pressure waves were observed in association with the elevated thunderstorms, yet these features were evidently not important in triggering the storms. An investigation of a convective band that formed above the frontal surface revealed that the development probably took place in two steps. Initially, the high potential temperature contour for a saturated environment in the air overlying the frontal inversion was stable to vertical displacements, but inertially unstable. Then, along the instantaneous path of the unstable parcel, the thermodynamic structure changed, the parcel became gravitationally unstable, and upright convection resulted. (See also W91-01481) (Author's abstract)  
W91-01482

**PRECIPITATION AND ENVIRONMENTAL CONDITIONS DURING ACCRETION IN CANADIAN EAST COAST WINTER STORMS.**  
Atmospheric Environment Service, Downsview (Ontario).  
R. E. Stewart, R. W. Crawford, N. R. Donaldson, T. B. Low, and B. E. Sheppard.  
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 7, p 525-538, July 1990. 13 fig, 1 tab, 28 ref, append.

Descriptors: \*Accretion, \*Canada, \*Ice formation, \*Meteorology, \*Precipitation, \*Storms, Air temperature, Freezing, Ice, Model studies, Particle shape, Remote sensing, Simulation, Snow, Wind velocity.

Ice and snow accretion cause a large amount of damage in winter storms with consequences ranging from slight to disastrous. Precipitation and environmental conditions occurring during accretion in Canadian east coast winter storms have been investigated. Accretion is generally associated with snow, freezing rain, and ice pellets within saturated conditions. Precipitation types are sometimes invariant but usually evolve during individual accretion events. Accretion events are also generally associated with moderate wind speeds (average of 7.5 m/s) and warm temperatures (between -1 C and 0 C are most common). Remote sensing of particle shapes and terminal velocities are capable of identifying some of the features of these precipitation types. Model calculations indicate that a detailed understanding of precipitation characteristics, such as the nature of wet snow, is needed to accurately simulate accretion. (Author's abstract)  
W91-01487

**AIRCRAFT-BASED RADIOMETRIC IMAGING OF TROPOSPHERIC TEMPERATURE AND PRECIPITATION USING THE 118.75-GHZ OXYGEN RESONANCE.**  
Georgia Inst. of Tech., Atlanta. School of Electrical Engineering.  
For primary bibliographic entry see Field 7B.  
W91-01488

## Field 2—WATER CYCLE

### Group 28—Precipitation

#### THUNDERSTORMS, COSMIC RAYS, AND SOLAR-LUNAR INFLUENCES.

M. D. Lethbridge.  
Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 95, No. 9, p 13,645-13,649, August 20, 1990. 4 fig, 25 ref.

Descriptors: \*Cosmic rays, \*Meteorology, \*Solar radiation, \*Synergistic effects, \*Thunderstorms, Frequency analysis, Geophysics, Particulate matter, Storms.

Cosmic ray and thunderstorm frequency was studied by superposed epoch analysis of thunderstorms over the eastern two thirds of the United States for 1957-1976. A decrease in thunderstorms was observed at the time of high cosmic rays and an increase in thunderstorms 2-4 days later. When data for spring and fall months were used, the minimum deepened again and was significant at less than the 0.01% level. It is believed that when the sun, earth, and moon are aligned, particulate matter in the lower stratosphere is modulated and acted upon by cosmic rays, bringing about an immediate decrease in thunderstorms. (Author's abstract)  
W91-01490

#### FOURIER DOMAIN SHAPE ANALYSIS METHODS: A BRIEF REVIEW AND AN ILLUSTRATIVE APPLICATION TO RAINFALL AREA EVOLUTION.

Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.  
P. Kumar, and E. Foufoula-Georgiou.  
Water Resources Research WREARQ, Vol. 26, No. 9, p 2219-2227, September 1990. 4 fig, 14 ref. NSF Grants CES-8708825 and BSC-8957469.

Descriptors: \*Fourier analysis, \*Mathematical analysis, \*Precipitation, \*Rainfall area, Weather forecasting.

Morphological shape analysis techniques offer valuable tools for the study of several hydrologic and atmospheric processes. Detailed description of patterns, as well as evolution and comparison of patterns can be efficiently performed in the Fourier domain and by means of a finite number of Fourier descriptors. Three Fourier domain shape analysis methods are briefly summarized: the complex plane method, the angular direction method, and the polar coordinates method. The complex plane method, applicable to any kind of shape, is more versatile than the other two methods and is also computationally efficient. The use of the complex plane method for studying the evolution of rainfall areas within a radar-depicted rainfall field for the purpose of short-term precipitation forecasting is illustrated. (Author's abstract)  
W91-01537

#### MONITORING OF RAINFALL IN RELATION TO THE CONTROL OF MIGRANT PESTS.

Reading Univ. (England). Dept. of Meteorology.  
J. R. Milford, and G. Dugdale.  
Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences PTRBAE, Vol. 328, No. 1251, p 689-704, June 30, 1990. 6 fig, 1 tab, 17 ref.

Descriptors: \*Habitats, \*Hydrologic budget, \*Insect control, \*Meteorology, \*Rainfall distribution, \*Satellite technology, \*Soil water, Remote sensing, Terrain analysis, Topography, Vegetation, Weather forecasting, Weed control.

Of all climatic parameters, rainfall has the greatest variability in space as well as time. It also has the greatest influence on the breeding and behavior of migrant pests, such as locusts, supplying the moisture needed both for their development and for the growth of vegetation to sustain a population. Soil moisture controls both processes directly but cannot be adequately surveyed even by remote sensing techniques, so water balance models are relied upon to interpret rainfall measurements and to forecast pest populations. Both terrain and rainfall are very inhomogeneous on the kilometeric scale, a scale which is not matched by observations either from conventional rain gages or current

meteorological satellites. Modeling the effects of rainfall must take account of these inhomogeneities. However, it is clear that more detailed studies of rainfall-habitat interaction are needed to derive soil moisture from rainfall estimates by using knowledge of the microtopography. Such relationships must be capable of being generalized so that future monitoring by satellites, essential to give complete and uniform coverage, can be realistically interpreted. (Author's abstract)  
W91-01561

#### RECORD-BREAKING RISE OF GREAT SALT LAKE IN 1981-1986 RELATED TO ANOMALOUS MID-TROPOSPHERIC WIND PATTERNS.

Scripps Institution of Oceanography, La Jolla, CA.  
For primary bibliographic entry see Field 2H.  
W91-01580

#### NEW EQUATION FOR THE ATMOSPHERIC ENERGY BUDGET (EINE NEUE GLEICHUNG FÜR DIE ATMOSPHERISCHEN ENERGIEHAUSHALTE).

Vienna Univ. (Austria). Inst. fuer Meteorologie und Geophysik.  
M. Hantel.  
Wetter und Leben WTLBAR, Vol. 41, No. 1/4, p 95-108, 1989. 4 fig, 16 ref. English summary.

Descriptors: \*Climatology, \*Mathematical equations, \*Meteorology, \*Weather forecasting, Energy, Latent heat, Precipitation, Rainfall.

The moisture budget equation of the atmosphere comprises mesoscale (routinely measurable) and sub-mesoscale (non-measurable) contributions. The sub-mesoscale terms are divergences of moisture flux and rain flux. These fluxes play an important role in the moisture budget. In order to diagnose them objectively the budget equation for sensible heat was added and coupled to the budget equation for latent heat via the rain flux. By means of the Bowen ratio in the free atmosphere the equations are closed, yielding a governing differential equation of the first order in pressure for the sub-mesoscale heat flux. This equation is in simple cases analytically solvable and in all cases numerically solvable. In this way the mesoscale atmospheric measurements yield the sub-mesoscale heat flux and, by means of algebraic and quadrature formulae, the rain and moisture flux. (Author's abstract)  
W91-01581

#### CHANGEABLE WEATHER-A CHAOTIC PHENOMENON TRIGGERED OFF BY MESOSCALE PRECIPITATION-EDDIES (WETTERLAUNEN ALS CHAOTISCHE MESO-SKALIGE STRUKTUREN).

Vienna Univ. (Austria). Inst. fuer Meteorologie und Geophysik.  
G. Skoda.  
Wetter und Leben WTLBAR, Vol. 41, No. 1/4, p 117-122, 1989. 2 fig, 1 tab, 6 ref. English summary.

Descriptors: \*Climatology, \*Cloud physics, \*Meteorology, \*Precipitation, Condensation, Logistic maps, Mathematical equations.

The rate of condensation quickly enters a chaotic region according to a simple nonlinear technique, the logistic map. The logistic map which is probably the simplest nonlinear difference equation, appears in many applications. Considering the process of condensation, if the number of cloud particles,  $N$ , grows at a given rate  $v$ , the iterations,  $N_{i+1}$ , of particle formation display a rather complicated behavior as a function of the external parameter  $v$ , which becomes chaotic at  $v$  greater than 2.5. As specific growth rates of condensation between different scales of precipitation-eddies are compared,  $v$  is found within the scales of MESO-beta, a structural lifetime which is greater than 36 hr, and MESO-gamma, 0.5 to 4 hr, with critical values of 2.5. This corresponds to the high intermittency of precipitation. High rates of condensation or cloud formation lead to precipitation eddies and the system enters a chaotic region. (Author's abstract)

W91-01582

#### EXTREME, SINGULAR AND COHERENT PRECIPITATION IN THE CATCHMENT BASIN OF THE UPPER INN RIVER (EXTREME, SINGULARE UND KOHAERENTE NIEDERSCHLAEGE IM GEBIET DES APLINEN INN).

F. Fliri.  
Wetter und Leben WTLBAR, Vol. 41, No. 1/4, p 141-152, 1989. 1 fig, 7 tab, 8 ref. English summary.

Descriptors: \*Austria, \*Precipitation, \*Storms, \*Weather patterns, Hydrographic models, Hydrographs, Inn River, Mathematical models, Rainfall.

Due to a series of sudden intense and individually catastrophic downpours which occurred in both parts of the Tirol in 1981, 1983 and 1985, a study was conducted by the University of Innsbruck and the Obervinschgau of Marienberg in 1985. Subsequently, more catastrophic instances occurred in the summer of 1987, and a regional hydrographic investigation was needed. Using daily precipitation values from 46 stations in the catchment basin of the upper Inn River (9313 square m) from 1946 to 1987 between Mont Blanc and Hohen Tauern, the mean annual and absolute maxima for periods of one, two and more consecutive days and estimates of 30 and 100 year maxima were determined. A relationship was established by means of a regression analysis between mean annual maxima and basin size that permitted estimates of extrema in smaller areas. The frequency distribution and extreme values of mean basin precipitation of periods of one or of several consecutive days are presented and the occurrence of spatially singular or coherent precipitation was determined to be dependent on precipitation totals. (Author's abstract)  
W91-01583

#### NEW SNOW IN THE URBAN AREA OF VIENNA (NEUSCHNEE IM RAUM WIEN). Zentralanstalt fuer Meteorologie und Geodynamik, Vienna (Austria).

H. Mohnl.  
Wetter und Leben WTLBAR, Vol. 41, No. 1/4, p 269-277, 1989. 6 fig, 2 tab, 4 ref. English summary.

Descriptors: \*Austria, \*Public policy, \*Snow forecasting, \*Snow management, \*Statistical models, \*Weather forecasting, Climatic data, Precipitation, Roads, Snow accumulation, Vienna.

In urban areas, freshly fallen snow is an undesired phenomenon because it generates substantial problems for public traffic and technical systems. Therefore, in regional planning, climatic statistical parameters like means, percentiles of the frequency distributions, and return periods of extreme values for the amount of freshly fallen snow are used to optimize the fundamental relationships between human life and the climate. Between 1951/52 and 1980/81, statistics were collected within the city of Vienna and the bordering Vienna Woods on the height of new fallen snow. The data from areas influenced by the heat of the city show a strong linear dependence at the levels of lowlands (from 200 m to 500 m) on altitude. The data were filtered with a Gaussian low pass to suppress periods of less than 20 years to show the variation of the annual amount of freshly fallen snow within the past 90 years. (Author's abstract)  
W91-01584

#### USE OF POLARIZATION TO CHARACTERIZE PRECIPITATION AND DISCRIMINATE LARGE HAIL.

National Severe Storms Lab., Norman, OK.  
N. Balakrishnan, and D. S. Zmric.  
Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 13, p 1525-1540, July 1990. 11 fig, 59 ref, 2 append.

Descriptors: \*Data acquisition, \*Hail, \*Meteorology, \*Polarimetric radar measurements, \*Precipitation, \*Radar, \*Rain, Correlation analysis, Correlation coefficient, Hydrometeors, Reflectance, Reflectance techniques, Reflectivity, Remote sensing.

## Precipitation—Group 2B

Polarimetric radar measurements provide bulk estimates of the shapes of the ensemble of hydrometeors in the radar resolution volume. There is evidence that the shape of a rain drop is related to its size. Also, rain drops exhibit little or no canting and fall with their minor axes oriented vertically. The work of Seliga and Brangi showed that the existence of such accurate relation between rain drop shape and size can be exploited to obtain an improved estimation of rainfall from polarimetric measurements. An examination was made of the utility of the correlation coefficient between linear orthogonally polarized echoes for determining precipitation type and gaging hail size. Models and measurements from pure rain coincide in predicting very high correlations (0.98); similar results are obtained with pure hail. Several mechanisms could cause the lowering of the correlation but the behavior of the examined data is definitely attributed to a mixture of hydrometeor types. This decrease is an indicator of hail size, it is shown theoretically that in at least two other realistic situations the correlation would decrease the hail size. For the examined case a model of hail shape and orientation during fall is able to reproduce the essential features of polarimetric measurements. It suggests, together with data obtained in the current investigation and data from other investigations, that substantial negative differential reflectivity (about -1 dB) in a region of high reflectivity factor values is caused by hailstones larger than about 2 cm in diameter. (Author's abstract)  
W91-01656

#### ENTRAINMENT AND MIXING PROCESSES AS RELATED TO DROPLET GROWTH IN WARM MIDLATITUDE AND TROPICAL CLOUDS.

Centre National de la Recherche Scientifique, CRPA, Magny les Hameaux, France.  
E. Hicks, C. Pontikis, and A. Rigaud.  
Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 13, p 1589-1618, July 1990. 30 fig, 6 tab, 55 ref, append.

Descriptors: \*Cloud physics, \*Clouds, \*Condensates, \*Entrainment, \*Meteorological data, \*Mixing, \*Precipitation, \*Rain, Data acquisition, Data collections, France, Tropical regions.

Aircraft measurements in warm continental cumuli and in tradewind maritime bandclouds are analyzed in order to determine the influence of entrainment and mixing processes on the evolution of condensate droplet spectrum. The results provide some insight on the similarities and differences between maritime and continental warm cumuli as related to warm rain production. The entrainment sources are determined by Paluch's thermodynamic method and contrasting results are obtained. Cloud top entrainment prevails in the midlatitude isolated cumuli whereas bandclouds of both data sets are subject to multilevel lateral entrainment. Microphysical characteristics such as the droplet concentration and the spectral peak radius are analyzed in relation to the dilution degree of cloud parcels in order to examine the mixing process involved during entrainment events. The findings support the inhomogeneous mixing hypotheses with total evaporation of some droplets of all sizes during mixing in all observed continental cases, whereas the dominant process in all studied maritime clouds is closer to the homogeneous picture. In both databases, the highest concentrations of droplets in the large droplet tail of the spectrum are found in samples with an intermediate level of dilution, thus confirming the influence of dilution on enhanced droplet growth. The role of entrainment, mixing and subsequent cloud dilution in the production of large droplets as shown seriously restricts the use of simple parameterizations of precipitation water initiation in cloud models. (Author's abstract)  
W91-01657

#### PRECIPITATION PRODUCTION IN A LARGE MONTANA HAILSTORM: AIRFLOW AND PARTICLE GROWTH TRAJECTORIES.

National Center for Atmospheric Research, Boulder, CO.  
L. J. Miller, J. D. Tuttle, and G. B. Foote.

Journal of the Atmospheric Sciences JAHSAK, Vol. 47, No. 13, p 1619-1646, July 1990. 23 fig, 1 tab, 67 ref.

Descriptors: \*Cloud physics, \*Hail, \*Meteorology, \*Precipitation, \*Radar, Air circulation, Clouds, Doppler radar measurements, Graupel, Precipitation mapping, Weather.

Computations of air motion and precipitation growth using winds derived from Doppler radar measurements were analyzed to reveal important flow features that influenced the production of precipitation during the nearly steady phase of a well-observed severe storm in Montana that produced hail as large as 5 cm in diameter. Based on particle growth calculations, measurements by radar and research aircraft, cloud photography and direct hailstone examination, four general sources of hail embryos were apparent: (1) graupel grown along the updraft fringes, (2) a derivative of the former consisting of drops produced by melting graupel, (3) water drops shed from melting hail, and (4) shedding from hailstones that were in wet growth conditions. The graupel embryos were deduced to originate primarily in two columnar regions on the flanks of the updraft core. Following the embryo growth stage, three types of hail growth trajectories were found: (1) those passing into the southern (cyclonic) branch of the middle-to-upper level airflow, (2) those passing into the northern (anticyclonic) branch of this flow, and (3) those passing in a nearly straight line through the updraft core in midlevels (preferentially the north-eastern side of the core). Of these the straight-line trajectory produced the largest hail. Precipitation from graupel grown in the western updraft fringes, from drops produced by transport and melting of these graupel grown in the northern updraft fringes was necessary to explain the observed patterns of radar reflectivity, dual-wavelength ratio and specific attenuation. Further, only embryos from the west and south flanks led to large diameter hail near where stones of similar sizes were observed from aircraft near the ground. (Author's abstract)  
W91-01658

#### USE OF DAILY VALUES OF SURFACE PARAMETERS AT DURBAN AND CAPE TOWN TO DETERMINE THE PRECIPITABLE WATER CONTENT OF THE ATMOSPHERE.

Natal Univ., Pietermaritzburg (South Africa).  
Dept. of Geography.  
O. S. McGee, and R. N. De Vos.

South African Journal of Science SAJSAR, Vol. 85, No. 9, p 602-603, September 1989. 2 tab, 3 ref.

Descriptors: \*Air circulation, \*Meteorological data collection, \*Meteorology, \*Precipitation, \*Regression analysis, \*South Africa, \*Water vapor, Data collections, Data interpretation, Dewpoint, Mathematical studies, Synoptic analysis, Temperature.

The precipitable water (vapor) or total content of vapor above any locality on the earth's surface plays an important role in hydrology and meteorology. Its value has been shown to differ according to the local airflow regime which prevails at the time and may be predicted from surface dewpoint values using a linear regression equation which is specific to the prevailing airflow type. This type of regression equations is customarily based on monthly mean values of precipitable water and surface dewpoint. South African upper air data was examined to show that daily values may be used, without combining them into monthly values, to generate multiple linear regression equations which differ for different airflow types and according to season. A preliminary investigation of upper air data for both Cape Town and Durban between 1969 and 1987 included the calculated precipitable water vapor, as well as surface temperature, dewpoint temperature, air pressure and wind speed. Exploratory regression analyses of precipitable water values vs. surface dewpoint temperatures were performed at each station. A multiple regression was then performed using all selected variables. The use of the daily data (not monthly statistics) was found to be dependent on the determination of airflow types at the surface. Since

this was done by computer, the actual synoptic situations at the stations should be distinguished. This would presumably lead to different data groupings. (Korn-PTT)  
W91-01660

#### CLIMATIC CONTROL OF VEGETATION DISTRIBUTION: THE ROLE OF THE WATER BALANCE.

Cornell Univ., Ithaca, NY. Section of Ecology and Systematics.

N. L. Stephenson.

American Naturalist AMNTA4, Vol. 135, No. 5, p 649-670, May 1990. 4 fig, 2 tab, 85 ref.

Descriptors: \*Climatology, \*Distribution patterns, \*Ecology, \*Hydrologic budget, \*Literature review, \*Vegetation, Energy, Evapotranspiration, Precipitation, Temperature, Water deficit.

The water balance describes climate as it is sensed by plants: as the interaction of energy and water in the environment. Discriminant analysis showed that the distribution of North American plant formations was more highly correlated with the water balance (actual evapotranspiration and deficit) than the more traditional measures of climate (such as temperature and precipitation) used in other studies. Much of the improved correlation could be contributed to the ability of the water balance to distinguish between climates similar in mean annual energy and water supplies, but different in the seasonal timing of the two. Consideration of the water balance aided in the interpretation of possible mechanisms controlling the distribution of plant formations. For example, coniferous forests occurred at low actual evapotranspiration (low simultaneous availability of water and energy), consistent with the suggestion that conifers are better adapted than deciduous trees to environments with a low potential for primary production. A better understanding of the mechanisms by which climate can control the distribution of vegetation will help in predicting the effects of changing climate on the future distribution of vegetation types. This literature review article attempts to enhance current understanding by discussing: (1) the relationship between the energy balance and the water balance; (2) biological importance of the water balance; (3) correlations between vegetation and climate; (4) statistical comparisons between the water balance and other climatic parameters; (5) the distribution of North American plant formations relative to the water balance; and (6) the distribution of coniferous and deciduous forests. (Lantz-PTT)  
W91-01684

#### CO2 CLIMATE SENSITIVITY AND SNOW-SEA-ICE ALBEDO PARAMETERIZATION IN AN ATMOSPHERIC GCM COUPLED TO A MIXED-LAYER OCEAN MODEL.

National Center for Atmospheric Research, Boulder, CO.

For primary bibliographic entry see Field 5C.  
W91-01694

#### PERSPECTIVE ON EL NINO AND LA NINA: GLOBAL IMPLICATIONS FOR STREAM ECOLOGY.

New Mexico Univ., Albuquerque. Dept. of Biology.

M. C. Molles, and C. N. Dahm.

Journal of the North American Benthological Society JNASEC, Vol. 9, No. 1, p 68-76, March 1990. 3 fig, 1 tab, 66 ref. NSF Grant Nr. BSR-8616438.

Descriptors: \*Climatology, \*El Nino, \*El Nino/Southern Oscillation, \*Gila River, \*La Nina, \*Meteorology, \*Pecos River, \*Streamflow forecasting, \*Weather forecasting, New Mexico.

Analyses of flow data for the Gila (60 years) and Pecos (68 years) Rivers in New Mexico showed that spring flows during snowmelt were significantly increased during El Nino years (periods of elevated sea surface temperature and reduced barometric pressure in the eastern tropical Pacific) and

## Field 2—WATER CYCLE

### Group 2B—Precipitation

significantly decreased during La Nina years (periods of reduced sea surface temperature and elevated barometric pressure). Over the period of record for these two rivers, mean spring runoff during El Nino years was 2.3 to 3.2 times higher than during medial years and 6.0 to 7.4 times higher than during La Nina years. The results of this study indicate a strong correspondence between El Nino-Southern Oscillation (ENSO) phenomena and stream flow in New Mexico. These results also suggest that, in this region, the increasingly accurate, and remote forecasting of ENSO phenomenon, often months in advance of the event, could be used to place future studies of biotic responses to variations in flow on a more predictive basis. Since it has been shown that the ENSO phenomenon affects the weather of large portions of the North American continent and tropical and subtropical regions worldwide, a similar potential for improved study designs exists for other regions. (Author's abstract)

W91-01811

**RAINWATER ACIDITY AT JABIRU, AUSTRALIA, IN THE WET SEASON OF 1983/84.**  
Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of Atmospheric Research.

For primary bibliographic entry see Field 5B.  
W91-01818

**CHEMICAL COMPOSITION OF BULK PRECIPITATION ACROSS THE MOUNTAINS OF SNOWDONIA, U.K.**  
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.

B. Reynolds, T. G. Williams, and P. A. Stevens. Science of the Total Environment STENDL, Vol. 92, p 223-234, March 1990. 4 fig, 5 tab, 19 ref.

Descriptors: \*Acid rain, \*Chemical composition, \*Chemistry of precipitation, \*Meteorology, \*Path of pollutants, \*Precipitation, \*Spatial distribution, Data collections, Meteorological data collection, Topography, Variability, Wales.

Bulk precipitation chemistry was monitored monthly for 18 months at 10 mountain sites and one coastal site in north Wales, U. K. The sites ranged in altitude from sea level to 891 m above sea level in an area where annual rainfall ranges from 1300 to 4000 mm. The precipitation was acidic (weighted mean H(+) of 23 microequivalents/L, pH 4.64), although ionic composition was dominated by sea salts. However, approximately 70% of the SO<sub>4</sub> was not of sea salt origin. Concentrations of excess SO<sub>4</sub> and NO<sub>3</sub> were small (42 and 11 microequivalents/L, respectively) relative to polluted areas of Europe, although deposition rates were large (1.62 g S/sq m/year and 0.54 g N/sq m/year as NO<sub>3</sub>) due to the high annual rainfall. There was considerable spatial variability in the solute concentrations and deposition data which resulted from the effects of the complex topography of the area. Simple linear relationships between solute deposition and rainfall quantity were not generally observed except for sea salt deposition on seaward north-west facing slopes. (Author's abstract)

W91-01820

**RAINFALL INDUCED SOIL SEAL: (A) A CRITICAL REVIEW OF OBSERVATIONS AND MODELS.**

Hebrew Univ., Rehovoth (Israel). Dept. of Soil and Water Sciences.

For primary bibliographic entry see Field 2G.  
W91-01872

**RAINFALL INDUCED SOIL SEAL: (B) APPLICATION OF A NEW MODEL TO SATURATED SOILS.**

Hebrew Univ., Rehovoth (Israel). Dept. of Soil and Water Sciences.

For primary bibliographic entry see Field 2G.  
W91-01873

### 2C. Snow, Ice, and Frost

**DIURNAL VARIATIONS IN THE INORGANIC SOLUTE CONTENT OF WATER DRAINING FROM AN ALPINE SNOWPATCH.**

Heidelberg Univ. (Germany, F.R.). Geographisches Inst.

For primary bibliographic entry see Field 2K.  
W91-01083

**MODIFIED KOEPPEN CLASSIFICATION APPLIED TO MODEL SIMULATIONS OF GLACIAL AND INTERGLACIAL CLIMATES.**

Wisconsin Univ.-Madison. Center for Climatic Research.

For primary bibliographic entry see Field 2B.  
W91-01091

**SURFACE ENERGY BALANCE OF A PERENNIAL SNOWBANK, MELVILLE ISLAND, NORTHWEST TERRITORIES, CANADA.**

Erindale Coll., Mississauga (Ontario). Dept. of Geography.

K. L. Young, and A. G. Lewkowicz. Arctic and Alpine Research ATLPAV, Vol. 22, No. 3, p 290-301, August 1990. 9 fig, 1 tab, 48 ref.

Descriptors: \*Arctic regions, \*Climatology, \*Energy, \*Melville Island, \*Permafrost, \*Snowpack, Ablation, Albedo, Canada, Latent heat, Radiation, Snowmelt.

The energy balance of a large perennial snowbank located in the continuous permafrost zone was examined during the summer of 1986. Three meteorological towers allowed energy fluxes to be determined for separate zones of the snow bank. Over the melt season, net radiation accounted for 85% of the energy absorbed by the snow surface, while sensible heat contributed 15% and latent heat was a net loss of 2%. Albedo varied across the snowbank due to an irregular distribution of surface aeolian deposits. Direct measurements of snowmelt from a snow survey compare favorably with calculated values obtained from the energy balance. The net shortwave radiation flux was a significant influence on ablation, explaining an average 77% of the variance in the measured melt. The predominance of the radiant fluxes is attributed to the large size of the snowbank and its sustained melt through the cool arctic summer. (Author's abstract)

W91-01370

**ESTIMATE OF SNOW AVALANCHE DEBRIS TRANSPORT, KAGHAN VALLEY, HIMALAYA, PAKISTAN.**

Waterloo Univ. (Ontario). Dept. of Geography.

For primary bibliographic entry see Field 2J.  
W91-01371

**INFLUENCE OF HUDSON BAY RUNOFF AND ICE-MELT ON THE SALINITY OF THE INNER NEWFOUNDLAND SHELF.**

Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.

For primary bibliographic entry see Field 2E.  
W91-01432

**SEASONAL DESCRIPTION OF THE QUALITY AND QUANTITY OF SNOWMELT IN A MOUNTAINOUS REGION USING AN INTEGRATED MODEL.**

Slovenska Akademia Vied, Bratislava (Czechoslovakia). Ustav Hydrologie a Hydrauliky.

G. Babiakova, D. Palkovic, and D. Bodis. Hydrological Sciences Journal HSJODN, Vol. 35, No. 4, p 383-393, August 1990. 5 fig, 2 tab, 9 ref.

Descriptors: \*Acid rain, \*Model studies, \*Mountains, \*Path of pollutants, \*Snow cover, \*Snowmelt, \*Sulfates, \*Water quality, Alpine regions, Catchment areas, Chemical analysis, Chemical properties, Czechoslovakia, Hydrological models, Runoff, Seasonal storage, Seasonal variation, Snow sampling.

An integrated model for the simulation and prediction of snowmelt quantity and quality from seasonal snow cover in a mountain basin has been developed in Czechoslovakia. To find the best method for modeling snow accumulation, and the accumulation of SO<sub>4</sub>(-2) washout, an approach was attempted which would satisfactorily combine hydrological and chemical modules. Surface runoff acidity and precipitation acidity were related by quantifying the progressive hydrological and chemical input and output sequences of the physical components. The Bystranka drainage basin was considered to be representative of accumulation under mountain conditions. Measurements of snow cover were supplemented by sampling for snow quality, to characterize the accumulation and evaluate the chemical composition of both the snow and stream water, and to find out the concentration of sulfate at various sampling points throughout the winter season. From the daily SO<sub>4</sub>(-2) measurements, it was found that in periods without any SO<sub>4</sub>(-2) coming from the basin, the change in the flow corresponded to the outflow curve equation. The values of the sulfate concentration were influenced by their source, a rock medium. With the discharge increase which follows from snowmelt or precipitation, an increase of SO<sub>4</sub>(-2) contents occurs. This increase or decrease in the SO<sub>4</sub>(-2) concentration depends upon the discharge amount and the duration of the contribution episode. The whole model was tested using data for three winter seasons, wherein it was concluded that the model only moderately satisfies the fitting requirements. Differences which occur between the measured and calculated values occur in the period of intensive snowmelt. (Fish-PTT)

W91-01460

**PREDICTION MODEL FOR SNOWMELT, SNOW SURFACE TEMPERATURE AND FREEZING DEPTH USING A HEAT BALANCE METHOD.**

Tohoku Univ., Sendai (Japan). Geophysical Inst. J. Kondo, and T. Yamazaki.

Journal of Applied Meteorology JAMOAX, Vol. 29, No. 5, p 375-384, 1990. 11 fig, 20 ref, 3 append.

Descriptors: \*Data interpretation, \*Flood forecasting, \*Meteorological data, \*Model studies, \*Simulation analysis, \*Snowmelt, \*Streamflow forecasting, Air temperature, Albedo, Dams, Humidity, Model testing, Snow cover, Solar radiation, Thermal conductivity, Water resources management, Wind velocity.

The evaluation of snowmelt is not only important in the effective utilization of water resources and the forecasting of flood runoff, but it also influences climate through the change in ground surface properties. A model of snowmelt was developed on the basis upon the heat balance of the snow cover, with the assumption of a linear temperature profile in the snow. The model predicts the amount of snowmelt, the heat balance components, the snow surface temperature, and freezing depth. The components necessary as the input data to the model are: the solar radiation, downward longwave radiation, wind velocity, air temperature, and humidity. Also, for the parameters of snow cover: the albedo, density, water content, and thermal conductivity need to be known prior to the calculation. This simulated process of snowmelt agrees well with observations made over a flat farmland. Moreover, the calculated snow surface temperature corresponds with the actual value. As the maximum water content or thermal conductivity increases, the calculated snowmelt decreases because the snow surface temperature is kept higher during the night for larger maximum water content and thermal conductivity. Snowmelt largely depends on albedo. Finally, the model was applied to a large area to estimate inflow to a dam. In this calculation, it was assumed that the initial snow water equivalent increased linearly with altitude. The predicted values of inflow are consistent with those observed. (Fish-PTT)

W91-01469

**PERSISTENCE OF SEEDING EFFECTS IN A WINTER OROGRAPHIC CLOUD SEEDING**

## Streamflow and Runoff—Group 2E

**WITH SILVER IODIDE BURNED IN ACETONE.**  
Bureau of Reclamation, Auburn, CA.  
For primary bibliographic entry see Field 3B.  
W91-01473

**PRECIPITATION AND ENVIRONMENTAL CONDITIONS DURING ACCRETION IN CANADIAN EAST COAST WINTER STORMS.**  
Atmospheric Environment Service, Downsview (Ontario).  
For primary bibliographic entry see Field 2B.  
W91-01487

**VARIATIONAL SENSITIVITY ANALYSIS, DATA REQUIREMENTS, AND PARAMETER IDENTIFICATION IN A LEAKY AQUIFER SYSTEM.**  
California Univ., Los Angeles. Dept. of Civil Engineering.  
W. W. G. Yeh, and N. Z. Sun.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 1927-1938, September 1990. 8 fig, 10 tab, 26 ref. NSF Contract CES8814888, USGS Contract 14-08-0001-G1499.

Descriptors: \*Aquifer systems, \*Data requirements, \*Groundwater movement, \*Leaky aquifers, \*Mathematical models, \*Model studies, \*Sensitivity analysis, Algorithms, Aquifers, Confined aquifers, Error analysis, Pumping tests, Unconfined aquifers.

The adjoint state sensitivity method was developed to aid the analysis of a pumping test design for parameter identification in a leaky aquifer system. The system considered consists of an unconfined aquifer overlying an aquitard which overflows a confined aquifer. The adjoint equations are derived in the continuous form without discretizing the governing equations and are expressed in terms of 'convection-diffusion' equations with time dependent coefficients. The multiple cell balance (MCB) method was used to solve the nonlinear governing equations as well as their adjoint equations. Algorithms were developed for calculating sensitivity coefficients of heads in each layer of an aquifer with respect to various parameters. A concept called 'contribution of an observation' is introduced which can be used to measure the usefulness of an observation in connection with data requirements for parameter identification. It links experimental design with observation errors and the requirement of model application. The sufficiency of an observation system for parameter identification can be evaluated at the design stage before extensive resources are committed to data collection. A numerical example is given to verify the proposed method and to explain its applicability to the design of a pumping test. (Author's abstract)  
W91-01512

**EXPERIENCE WITH PRECIPITATION FORECASTING FOR THE WINTER ROAD SERVICE (ERFAHRUNGEN MIT NIEDERSCHLAGS-PROGNOSEN FUER DEN STRASSENWINTERDIENST).**  
Zentralanstalt fuer Meteorologie und Geodynamik, Vienna (Austria).  
H. Bica, and H. Falkel.  
Wetter und Leben WTLBAR, Vol. 41, No. 1/4, p 67-75, 1989. 1 fig, 9 tab, 2 ref. English summary.

Descriptors: \*Austria, \*Snow accumulation, \*Snow management, \*Snow removal, \*Weather forecasting, Burgenland, Precipitation, Public policy, Roads.

Since the winter of 1985-1986, The Department of Synoptic Meteorology of the Central Office of Meteorology and Geodynamics (ZAMG) produced weather forecasts to determine the needs of the winter road service in Lower Austria and during the 1986-1987 season for Burgenland as well. During the first winter, forecasts were made twice daily, once in the morning and once in the afternoon for eight sects of the Autobahn in Lower Austria. In the second season, forecasts were made four times a day, at 6 AM, 11 AM, 3 PM, and 10 PM for 27 sectors of road including Burgenland.

The forecasts of precipitation in the first season were correct 88% of the time and none of the eight sectors were correct less than 83% of the time. The first large-scale testing has shown that the available network of stations feeding weather information back from the Autobahn ministry is still not always ideal for the different regions. The network of stations must be expanded with more tightly packed stations over a larger area and more frequent measurements. Also, more accurate data should be obtained on the temperature of road surfaces, especially bridges, moisture on road surfaces, and ground winds. (King-PTT)  
W91-01579

**NEW SNOW IN THE URBAN AREA OF VIENNA (NEUSCHNEE IM RAUM WIEN).**  
Zentralanstalt fuer Meteorologie und Geodynamik, Vienna (Austria).  
For primary bibliographic entry see Field 2B.  
W91-01584

## 2D. Evaporation and Transpiration

**EFFECTS OF CLEARFELLING A SITKA SPRUCE STAND ON THE WATER BALANCE OF A PEATY GLEY SOIL AT KERSHOPPE FOREST, CUMBRIA.**  
Forestry Commission, Midlothian (Scotland). Northern Research Station.  
For primary bibliographic entry see Field 4C.  
W91-01069

**EVAPOTRANSPIRATION, WATER USE EFFICIENCY, MOISTURE EXTRACTION PATTERN AND PLANT WATER RELATIONS OF RAPE (BRASSICA CAMPESTRIS) GENOTYPES IN RELATION TO ROOT DEVELOPMENT UNDER VARYING IRRIGATION SCHEDULES.**  
Haryana Agricultural Univ., Hissar (India).  
V. Raja, and K. C. Bishnoi.  
Experimental Agriculture EXAGAL, Vol. 26, No. 2, p 227-233, April 1990. 1 fig, 5 tab, 8 ref.

Descriptors: \*Evapotranspiration, \*Irrigation effects, \*Rapeseed, \*Root development, \*Soil-water-plant relationships, \*Water use efficiency, India, Irrigation requirements, Plant growth, Plant physiology, Plant water potential, Soil types.

A field experiment was conducted on sandy loam soil at Hissar, India, during the autumn seasons 1984 to 1985 and 1985 to 1986 to study rape genotypes under varying irrigation schedules. Root volume and dry weight increased, while tap root and lateral root lengths decreased with irrigation. Increased irrigation frequency increased evapotranspiration but decreased water use efficiency. The relative water content and osmotic potential of the leaves increased with more frequent irrigation, but plant water retention capacity decreased. There were genotypic differences between the characters examined. Out of the five genotypes examined (Sangam, T-9, B-54, TH-72, and TH-84), genotypes T-9 and Sangam are recommended for use with irrigation and B-54 for use under unirrigated conditions. (Author's abstract)  
W91-01114

**PREDICTING WATER USE AND WATER APPLICATION EFFICIENCIES FOR DIFFERENT IRRIGATION DEPTHS IN WHEAT.**  
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soil and Water Engineering.  
For primary bibliographic entry see Field 3F.  
W91-01115

**WATER BODY EVAPORATION EXPERIMENT OF POYANG LAKE (IN CHINESE).**  
Hydrometeorological Experiment Station of Poyang Lake, Xingzi (China).  
For primary bibliographic entry see Field 2H.  
W91-01576

**ANALYSIS OF AIR TEMPERATURE EFFECT ON TAIHU LAKE (IN CHINESE).**

Academia Sinica, Nanjing (China). Inst. of Geography.  
For primary bibliographic entry see Field 2H.  
W91-01577

## 2E. Streamflow and Runoff

**BIOGEOCHEMISTRY OF CARBON IN THE AMAZON RIVER.**  
Washington Univ., Seattle. School of Oceanography.  
For primary bibliographic entry see Field 5B.  
W91-01039

**FLOODPLAIN DYNAMICS OF A WANDERING RIVER, DENDROCHRONOLOGY OF THE MORICE RIVER, BRITISH COLUMBIA, CANADA.**  
Northwest Community Coll., Terrace (British Columbia).  
A. S. Gottesfeld, and L. M. Johnson-Gottesfeld.  
Geomorphology GEMPEZ, Vol. 3, No. 2, p 159-179, June 1990. 13 fig, 2 tab, 43 ref.

Descriptors: \*Canada, \*Channel morphology, \*Dendrochronology, \*Flood plains, \*Geomorphology, \*Meanders, \*Morice River, \*Paleohydrology, Channels, Debris flow, Floods, History, River flow, Tree rings, Trees.

Dendrochronological techniques were used to develop a history of flood occurrence and relative stage for the middle section of the Morice River based on flood scars, bank undercutting dates and tree establishment dates on fluvial features. Thirty-one significant floods over the past 105 years were detected through dendrochronology of flood scarred trees. On the Morice River, flood scars are predominantly caused by flood-transported logs. Abundant log transport results in damage to channel margin trees during events only slightly above bankfull discharge. The record of flood scars on channel margin trees and establishment dates of forest stands on abandoned channels and surfaces show that the Morice River has maintained its present regimen for the past 115 years. During the Neoglacial age the Morice river was more active than in recent times, and its channels occupied twice the present area. Tree-establishment dates show that Neoglacial surfaces and channels of the Morice River were abandoned during the 1820's. The modern floodplain configuration was assumed by 1870. (Lantz-PTT)  
W91-01070

**FLOW AND PARTICLE PATHS AT A NATURAL RIVER CONFLUENCE WITH COARSE BED MATERIAL.**  
Montreal Univ. (Quebec). Dept. of Geography.  
For primary bibliographic entry see Field 2J.  
W91-01071

**APPLICATION OF A SIMPLE LUMPED RIVER FLOW FORECASTING MODEL TO HILLSLOPE SOIL WATER STORAGE ESTIMATION.**  
Kobe Univ. (Japan). Dept. of Agricultural Engineering.  
For primary bibliographic entry see Field 2G.  
W91-01086

**URBAN RUNOFF MODELING FOR ADMINISTRATIVE PURPOSES.**  
Wright Water Engineers, Inc., Denver, CO.  
For primary bibliographic entry see Field 4C.  
W91-01193

**APPLICATION OF SWMM IN THE NEW ORLEANS AREA.**  
Tulane Univ., New Orleans, LA.  
For primary bibliographic entry see Field 4C.  
W91-01195

**USE OF SWMM/EXTRAN AND TR-20 TO DEVELOP REGIONAL STORMWATER DETEN-**

## Field 2—WATER CYCLE

### Group 2E—Streamflow and Runoff

**TION PLANS IN THE WASHINGTON, D.C. REGION.**  
Camp, Dresser and McKee, Inc., Annandale, VA.  
For primary bibliographic entry see Field 4C.  
W91-01196

**HYDROLOGIC DATA AUTOMATION USING AUTOCAD.**  
Kiowa Engineering Corp., Denver, CO.  
For primary bibliographic entry see Field 7C.  
W91-01202

**DISTRIBUTED RAINFALL-RUNOFF MODELING BASED ON DIGITAL MAP DATABASE.**  
Colorado Univ. at Denver. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 7C.  
W91-01203

**PC-SYNOP, A RAINFALL ANALYSIS TOOL.**  
Woodward-Clyde Consultants, Oakland, CA.  
For primary bibliographic entry see Field 7C.  
W91-01204

**HYETOGRAPH COMPOSITING EFFECTS ON URBAN RUNOFF MODELLING.**  
Kiowa Engineering Corp., Denver, CO.  
For primary bibliographic entry see Field 7C.  
W91-01206

**FLOOD HYDROGRAPH FOR UNGAGED WATERSHED.**  
Stewart Environmental Consultants, Inc., Fort Collins, CO.  
For primary bibliographic entry see Field 7C.  
W91-01207

**UNIT-HYDROGRAPH PROCEDURES FOR ARID LANDS.**  
For primary bibliographic entry see Field 7C.  
W91-01208

**DETERMINATION OF DESIGNATED FLOODWAY BOUNDARIES AROUND LONG ISLANDS IN STREAM CHANNELS.**  
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.  
J. F. Harp.  
IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 217-223, 2 fig, 3 ref.

**Descriptors:** \*Backwater analysis, \*Channels, \*Computer programs, \*Data interpretation, \*Flood routing, \*Flow around objects, \*Islands, \*River flow, Flood flow, Flow profiles.

Whenever river islands are encountered in hydraulic analysis, special problems exist with respect to the proper application of most backwater package programs. This problem is due to flow divisions in the side channels that must remain constant, unless there are provisions for short circuiting the flows along the riverine pathway. The correct solution is achieved whenever the flows divide so that the head loss around each side-channel is the same. The correct flow division, and resulting backwater profile is achievable using the HEC-2 computer program. However, even with the computer assist, a trial and error procedure is required. This procedure utilizes one of three methods: (1) utilizes a large cross-section containing all the GR points, and a usual application of HEC-2 methodology; (2) assumes that the original flow ratio division remains constant, and two runs are made around the island using the tributary option and the preserved energy gradient; and (3) where smooth encroachment stations are set at outer reasonable delineations, and the side channel flows are rebalanced until equal head losses again occur around each side channel, while the incremented water surface is achieved. (See also W91-01188) (Lantz-PTT)  
W91-01209

### GULF COAST FLOOD ROUTING.

Wright Water Engineers, Inc., Denver, CO.  
R. L. Rossmiller, and K. R. Wright.  
IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 224-231, 1 tab, 6 ref.

**Descriptors:** \*Coastal waters, \*Flood routing, \*Gulf of Mexico, \*Storm runoff, \*Urban hydrology, \*Urban runoff, Bayous, Flood control, Flood flow, Urban areas, Water management, Wetlands.

Low elevation urban centers along the coast of the Gulf of Mexico require special flood control measures to provide adequate drainage. Of particular concern to the drainage engineer are the flat slopes of the land surface and channels with usual grades of 0.0002 to 0.0005 feet/foot. Flood flow modeling and routing of stormwater where bayou thalwegs may range from -5 to 10 feet below mid sea level (msl) are described at Beaumont, Texas. Plans for a mid-city interceptor channel are described which provide downstream bayou flood relief. Another potential southern interceptor channel would provide not only additional downstream bayou flood relief, but water quality improvement to the stormwater runoff as well. Information is gained from an investigation of runoff in a southern coastal city. The techniques investigated may prove useful in other locations as well. (See also W91-01188) (Lantz-PTT)  
W91-01210

**SUSPENSION AND SETTLEMENT OF PARTICLES IN FLOWING WATER: COMPARISON OF THE EFFECTS OF VARYING WATER DEPTH AND VELOCITY IN CIRCULATING CHANNELS.**  
Freshwater Biological Association, Ambleside (England). Windermere Lab.  
For primary bibliographic entry see Field 2J.  
W91-01340

**DISSOLVED ORGANIC CARBON CONCENTRATIONS AND FLUXES ALONG THE MOISIE RIVER, QUEBEC.**  
University Coll. of North Wales, Bangor. School of Animal Biology.  
For primary bibliographic entry see Field 2K.  
W91-01341

**FORESTS AND THE TEMPERATURE OF UPLAND STREAMS IN WALES: A MODELING EXPLORATION OF THE BIOLOGICAL EFFECTS.**  
University Coll., Cardiff (Wales). School of Pure and Applied Biology.  
N. S. Weatherly, and S. J. Ormerod.  
Freshwater Biology FWBLAB, Vol. 24, No. 1, p 109-122, August 1990. 7 fig, 4 tab, 54 ref.

**Descriptors:** \*Forest ecosystems, \*Land use, \*Model studies, \*Stream ecology, \*Temperature effects, \*Wales, \*Water temperature, Aquatic insects, Fish populations, Growth, Mayflies, Moors, Stoneflies, Trout.

Daily temperature data from six streams in upland Wales were used to explore the thermal effects of afforestation on stream ecology. The data were linked to published biological models to simulate fish and invertebrate development. Mean daily temperatures in forest streams were lower than those of moorland streams in spring and summer, and higher in winter. These spatial comparisons were supported by the results of experimental bank-side clearance at a forest site, where there was evidence that stream temperatures fell in winter and rose in spring following treatment. Simulations indicated that brown trout (*Salmo trutta*) could weigh over 30% more by the end of their second growing season in a moorland compared with a forest stream. Several species of insects showed slower simulated egg development at forest sites. For two ephemeropteran species simulated nymphal growth was also retarded, suggesting significant alterations to the life cycle. Two plecopteran species were affected only slightly by the different temperature regimes. The simulations suggested that afforestation, by reducing summer

temperatures, could lead to marked reductions in rates of development of some invertebrates and fish. (Author's abstract)  
W91-01343

**ECOLOGY OF TWO INTERMITTENT STREAMS IN VICTORIA, AUSTRALIA. I. MULTIVARIATE ANALYSES OF PHYSICO-CHEMICAL FEATURES.**

Monash Univ., Clayton (Australia). Centre for Stream Ecology.  
A. J. Boulton, and P. S. Lake.  
Freshwater Biology FWBLAB, Vol. 24, No. 1, p 123-141, August 1990. 8 fig, 8 tab, 48 ref.

**Descriptors:** \*Australia, \*Intermittent streams, \*Multivariate analysis, \*Physicochemical properties, \*Stream ecology, Conductivity, Dissolved oxygen, Flow characteristics, Flow velocity, Macroinvertebrates, Pools, Riffles, Temperature.

Amplitudes in physicochemical features in intermittent streams exceed those in nearby permanent streams and strongly influence macroinvertebrate community structure; however, this relationship has not been objectively described. Therefore, multivariate techniques of ordination and classification were applied to environmental data collected from pools and riffles at four sites on two intermittent streams in central Victoria, Australia, during a drought year followed by a wetter year. A cyclical sequence of flow phases was usually evident in pool and riffle habitats at all sites over both years: pre-flow, early flow, main flow, diminishing flow and post-flow. Several spates that occurred during the sampling period only briefly distorted the cyclical pattern. No single variable characterized these phases at each site; instead, the phases represented complex combinations of discharge, current velocity, dissolved oxygen, conductivity, water temperature and time-related variables. This highlights the advantages of an integrative, multivariate approach to seek patterns in environmental data, especially since physicochemical features are often highly inter-correlated. Although the temporal variation in most of the physicochemical variables at each site over both years was generally consistent, some differences could be ascribed to the low rainfall and discharges during the 1982 drought. Water temperature in the riffles closely reflected ambient air temperature, conductivity was usually greater, and dissolved oxygen seldom reached saturation, even in the riffles during the drought. During the wetter years after the 1982 drought, flow continued during summer at the study sites. Multivariate analyses indicated that a complete cycle in which the diminishing flow phase merged into the preflow phase would result. This is probably the usual situation in permanent streams in Australia. (White-Reimer-PTT)  
W91-01344

**INHIBITORY EFFECTS OF HIGH MOLECULAR WEIGHT DISSOLVED ORGANIC MATTER UPON METABOLIC PROCESSES IN BIOFILMS FROM CONTRASTING RIVERS AND STREAMS.**

University Coll. of North Wales, Bangor. School of Biological Sciences.  
For primary bibliographic entry see Field 2K.  
W91-01345

**MODELLING BLACK FLY PRODUCTION DYNAMICS IN BLACKWATER STREAMS.**

Alabama Univ., University. Aquatic Biology Program.  
For primary bibliographic entry see Field 2H.  
W91-01346

**STONEFLY PREDATION ALONG A HYDRAULIC GRADIENT: A FIELD TEST OF THE HARSH-BENIGN HYPOTHESIS.**

Cornell Univ., Ithaca, NY. Dept. of Entomology.  
For primary bibliographic entry see Field 2H.  
W91-01347

## Streamflow and Runoff—Group 2E

**ASSOCIATIONS OF AQUATIC INSECTS (EPHEMEROPTERA, PLECOPTERA, AND TRICHOPTERA) IN A NETWORK OF SUBARCTIC LAKES AND STREAMS IN QUEBEC.**  
Montreal Univ. (Quebec). Dept. of Biological Sciences.

For primary bibliographic entry see Field 2H.  
W91-01349

**SILTATION OF STONE-SURFACE PERIPHYTON IN RIVERS BY CLAY-SIZED PARTICLES FROM LOW CONCENTRATIONS IN SUSPENSION.**

Otago Univ., Dunedin (New Zealand). Dept. of Zoology.  
For primary bibliographic entry see Field 2J.  
W91-01353

**ANCIENT CHANNELS OF THE SUSQUEHANNA RIVER BENEATH CHESAPEAKE BAY AND THE DELMARVA PENINSULA.**

Geological Survey, Woods Hole, MA.  
For primary bibliographic entry see Field 2J.  
W91-01378

**COLONIZATION PROCESS OF A TYPICAL EPILITHIC ALGAL COMMUNITY—HOMOEOTHRIX JANTHINA-ACHNANTHES JAPONICA COMMUNITY—IN A LESS POLLUTED RIVER IN JAPAN (IN JAPANESE).**

For primary bibliographic entry see Field 2H.  
W91-01383

**SEASONAL AND LONG-TERM TRENDS IN TRUCKEE RIVER NUTRIENT CONCENTRATIONS AND TRUCKEE RIVER NUTRIENT CONCENTRATIONS AND LOADINGS TO PYRAMID LAKE, NEVADA: A TERMINAL SALINE LAKE.**

Fish and Wildlife Service, Columbia, MO.  
For primary bibliographic entry see Field 5B.  
W91-01425

**INFLUENCE OF HUDSON BAY RUNOFF AND ICE-MELT ON THE SALINITY OF THE INNER NEWFOUNDLAND SHELF.**

Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.  
R. A. Myers, S. A. Akenhead, and K. Drinkwater.  
Atmosphere - Ocean ATOCDA, Vol. 28, No. 2, p 241-256, June 1990. 10 fig, 37 ref.

Descriptors: \*Continental shelf, \*Hudson Bay, \*Melting, \*Newfoundland, \*Runoff, \*Salinity, \*Sea ice, Canada, Correlation analysis, Floating ice, Labrador Shelf, Mathematical analysis, Seasonal variation, Ungava Bay.

This study examines the sources of interannual variability in salinity on the Newfoundland continental shelf observed in a 40-year time series from an oceanographic station known as Station 27. Specifically, through lag-correlation analysis, the a priori hypotheses that the salinity anomalies at Station 27 are determined by freshwater runoff anomalies from Hudson and Ungava Bays and by ice-melt anomalies in Hudson Bay and on the Labrador Shelf were investigated. Interannual variations of summer runoff into Hudson Bay were significantly negatively correlated with salinity anomalies on the Newfoundland Shelf with a lag (9 months) that is consistent with expected travel times based on known current velocities in Hudson Bay and along the Labrador Shelf. Sea-ice extent over the Labrador and northern Newfoundland shelves was significantly negatively correlated with salinity at a lag of 3 to 4 months, corresponding to the time of minimum salinity at Station 27. It appears that ice-melt over the Labrador-northern Newfoundland Shelf is primarily responsible for the seasonal salinity minimum over the Newfoundland Shelf. Interannual variability in runoff into Ungava Bay and ice-melt in Hudson Bay were not correlated with interannual salinity variations on the Newfoundland Shelf. (Author's abstract)  
W91-01432

**STOCHASTIC MODELS OF STREAMFLOW: SOME CASE STUDIES.**

Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.

P. P. Mujumdar, and D. Nagesh Kumar.  
Hydrological Sciences Journal HSJODN, Vol. 35, No. 4, p 395-410, August 1990. 3 fig, 8 tab, 16 ref.

Descriptors: \*Hydrologic models, \*India, \*Model studies, \*Stochastic hydrology, \*Streamflow forecasting, \*Time series analysis, Case studies, Cauvery River, Data interpretation, Hemavathy River, Malaprabha River, Regression analysis, Streamflow, Water resources data.

The development and use of stochastic models of hydrological phenomena play an important role in water resources engineering, including their use to forecast river flows. The problem of model selection is an important one in time series analysis as there are an infinite number of possible models, and the choice of a wrong model may result in a costly decision. Out of the possible models of the Auto-Regressive Moving Average (ARMA) however, only a few need to be considered for modeling a given streamflow sequence. AR parameters of up to order 6 and MA parameters of up to order 2 would, in general, serve the purpose. Ten candidate models of the ARMA family (AR(1), AR(2), AR(3), AR(4), ARMA(1,1), ARMA(2,1), ARMA(3,1), ARMA(1,2) and ARMA(2,2)) were investigated for representing and forecasting monthly and ten-day streamflow in three Indian rivers. The best models for forecasting and data representation were selected using the criteria of Minimum Mean Square Error (MMSE) and Maximum Likelihood (ML). The selected models were validated for significance of the residual mean, significance of the periodicities in the residuals, and significance of the correlation in the residuals. The models selected, based on the ML criterion for the synthetic generation of the three monthly series are: AR(4) for the Cauvery River; ARMA(2,1) for the Hemavathy River; and ARMA(3,1) for the Malaprabha River. For the ten-day series of the Malaprabha River, the AR(4) model was selected. The AR(1) model resulted in a minimum mean square error in all the cases studied, and was recommended for use in forecasting flows one time step ahead. (Fish-PTT)  
W91-01461

**DEVELOPMENT, CALIBRATION AND FIELD TESTING OF A SOIL LOSS AND A RUNOFF MODEL DERIVED FROM A SMALL-SCALE PHYSICAL SIMULATION OF THE EROSION ENVIRONMENT ON ARABLE LAND IN ZIMBABWE.**

Institute of Agricultural Engineering, Harare (Zimbabwe).  
For primary bibliographic entry see Field 2J.  
W91-01478

**FLOW STABILITY AND FRICTION FACTOR IN ROUGH CHANNELS.**

Politecnico di Torino (Italy). Inst. di Idraulica.  
For primary bibliographic entry see Field 8B.  
W91-01494

**ADVECTION SIMULATION BY MINIMAX-CHARACTERISTICS METHOD.**

Hong Kong Polytechnic, Kowloon. Dept. of Civil and Structural Engineering.  
For primary bibliographic entry see Field 8B.  
W91-01496

**CHANGES IN STREAM MORPHOLOGY AND STORM TRANSPORT OF SEDIMENT FOLLOWING WATERSHED DISTURBANCE.**

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.  
For primary bibliographic entry see Field 2J.  
W91-01505

**ANNUAL STONEFLY (PLECOPTERA) PRODUCTION IN A SECOND ORDER OKLAHOMA OZARK STREAM.**

North Texas State Univ., Denton. Dept. of Biolog-

ical Sciences.

For primary bibliographic entry see Field 2H.  
W91-01506

**MEAN SQUARE ERROR OF REGRESSION-BASED CONSTITUENT TRANSPORT ESTIMATES.**

Geological Survey, Reston, VA.  
For primary bibliographic entry see Field 5B.  
W91-01522

**PROBLEMS IN DETERMINING THE RETURN OF A WATERSHED TO PRETREATMENT CONDITIONS: TECHNIQUES APPLIED TO A STUDY AT CASPAR CREEK, CALIFORNIA.**

Forest Service, Arcadia, CA.  
For primary bibliographic entry see Field 4C.  
W91-01523

**THEORETICAL MODEL OF OPTIMAL DRAINAGE NETWORKS.**

Virginia Univ., Charlottesville. Dept. of Environmental Sciences.  
A. D. Howard.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2107-2117, September 1990. 6 fig, 1 tab, 48 ref.

Descriptors: \*Catchment areas, \*Drainage patterns, \*Geomorphology, \*Model studies, \*Stream erosion, Channel morphology, Erosion, Stochastic models, Streamflow, Valleys.

A simulation model of drainage network optimization has been developed in which channels shift to minimize total stream power within the network. The simulation model starts from an arbitrary initial stream network developed on a square matrix, such as produced by random headward growth. Discrete stream capture is then simulated within the network, occurring wherever a new stream linkage would produce a steeper course than the original. Such capture produced a network with minimum power optimization but flow directions constrained to eight directions. Individual segment end points are allowed to migrate by iterative relaxation with a direction and rapidity of motion governed by the gradient of stream power at the node. This valley migration is subject to the constraint that the sources and outlet remain fixed. The resulting networks are visually and morphometrically more similar to natural stream networks than the original networks produced by the random headward growth model. (Author's abstract)  
W91-01526

**PRACTICAL ASPECTS OF LOW-FLOW FREQUENCY ANALYSIS.**

Melbourne Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering.  
R. J. Nathan, and T. A. McMahon.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2135-2141, September 1990. 3 fig, 5 tab, 24 ref.

Descriptors: \*Drought, \*Flow equations, \*Frequency analysis, \*Low flow, Forecasting, Mathematical analysis, Streamflow, Streamflow data.

Some practical aspects concerning the application of the Weibull distribution to low-flow frequency analysis were examined. Two-parameter and three-parameter forms of the distribution were fitted to a total of 987 distributions derived from the daily flow data of 134 catchments located in southeastern Australia. The relative performance of three estimation methods (moments, maximum likelihood, and probability weighted moments) was investigated, and it is found that the different estimation methods provide distinct sets of quantile estimates. The method of probability weighted moments is more likely to give unsatisfactory estimates of the smallest drought and in general tends to yield less severe estimates of drought volumes relative to the other two methods. The method of maximum likelihood occasionally provides estimates of drought volumes that are many times

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### Group 2E—Streamflow and Runoff

greater than that yielded by the methods moments or probability weighted moments. The differences between low-flow frequency estimates based on calendar and hydrologic years were also investigated. Low-flow frequency estimates based on calendar years overestimate low-flow volumes for durations of 3 mo and more, whereas the opposite effect is apparent for shorter durations. It is evident that drought estimates should be based on the hydrologic year, regardless of the duration considered. (Peters-PTT)  
W91-01529

**DEPRESSIONAL STORAGE FOR MARKOV-GAUSSIAN SURFACES.**  
National Soil Erosion Lab., West Lafayette, IN.  
For primary bibliographic entry see Field 2J.  
W91-01539

**STUDY OF POLLUTANT DIFFUSION IN THE JUJIANG SEGMENT OF THE CHANGJIANG RIVER (IN CHINESE).**  
Academia Sinica, Qingdao (China). Inst. of Oceanology.  
For primary bibliographic entry see Field 5B.  
W91-01571

**REACTION OF MICROBIAL PERIPHYTON TO SUBSTRATE CONCENTRATION CHANGES IN A RUNNING WATER MODEL.**  
Vyzkumny Ustav Vodohospodarsky, Prague (Czechoslovakia).  
For primary bibliographic entry see Field 2H.  
W91-01603

**HETEROTROPHIC MICROPLANKTON IN PLANKTON SUCCESSIONS AND SELF PURIFICATION PROCESSES ALONG THE YENISEI RIVER.**  
Oceanology Dept, Gelendzhik, Krasnodar, 353470 USSR.  
For primary bibliographic entry see Field 2H.  
W91-01616

**STREAMWATER ACIDIFICATION IN RELATION TO ACID PRECIPITATIONS-VEGETATION AND BEDROCK INFLUENCES, CONSEQUENCES FOR TROUT POPULATIONS: THE VOSGES MASSIF CASE STUDY (ACIDIFICATION DES EAUX DE SURFACE SOUS L'INFLUENCE DES PRECIPITATIONS ACIDES: ROLE DE LA VEGETATION ET DU SUBSTRATUM, CONSEQUENCES POUR LES POPULATIONS DE TRUITES, LE CAS DES RUISSEAUX DES VOSGES).**  
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.  
For primary bibliographic entry see Field 5C.  
W91-01738

**EFFECT OF NUTRIENT CONTENT ON LEAF DECOMPOSITION IN A COASTAL PLAIN STREAM: A COMPARISON OF GREEN AND SENESCENT LEAVES.**  
Savannah River Ecology Lab., Aiken, SC.  
For primary bibliographic entry see Field 2H.  
W91-01742

**COMPARISON OF DETRITUS PROCESSING BETWEEN PERMANENT AND INTERMITTENT HEADWATER STREAMS.**  
Central Michigan Univ., Mount Pleasant. Dept. of Biology.  
For primary bibliographic entry see Field 2H.  
W91-01744

**REDD SITE SELECTION BY BROWN TROUT IN DOUGLAS CREEK, WYOMING.**  
Wyoming Cooperative Fishery and Wildlife Research Unit, Laramie.  
For primary bibliographic entry see Field 8I.  
W91-01745

**NEW APPROACH FOR MEASURING COVER IN FISH HABITAT STUDIES.**  
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.  
For primary bibliographic entry see Field 2H.  
W91-01746

**ALGAE, OTHER THAN DIATOMS, AFFECTING THE DENSITY, SPECIES RICHNESS AND DIVERSITY OF DIATOM COMMUNITIES IN RIVERS.**  
Zurich Univ., Kilchberg (Switzerland). Hydrobiological-Limnological Station.  
For primary bibliographic entry see Field 2H.  
W91-01765

**BENTHIC COMMUNITY STRUCTURE AND THE EFFECT OF ROTENONE PISCICIDE ON INVERTEBRATE DRIFT AND STANDING STOCKS IN TWO PAPUA NEW GUINEA STREAMS.**  
Hong Kong Univ. Dept. of Zoology.  
For primary bibliographic entry see Field 2H.  
W91-01767

**STUDIES ON THE CHEMISTRY OF INTERSTITIAL WATER TAKEN FROM DEFINED HORIZONS IN THE FINE SEDIMENTS OF BIVALVE HABITATS IN SEVERAL NORTHERN GERMAN LOWLAND WATERS: I. SAMPLING TECHNIQUES.**  
Tierärztliche Hochschule Hannover (Germany, F.R.). Inst. fuer Zoologie.  
For primary bibliographic entry see Field 2H.  
W91-01768

**DISTRIBUTION AND PRIMARY PRODUCTIVITY OF THE EPIZOIC MACROALGA BOLDIA ERYTHROSIPHON (RHODOPHYTA) IN A SMALL ALABAMA STREAM.**  
Alabama Univ., University. Aquatic Biology Program.  
For primary bibliographic entry see Field 2H.  
W91-01805

**EFFECTS OF HERBIVORE TYPE AND DENSITY ON TAXONOMIC STRUCTURE AND PHYSIOGNOMY OF ALGAL ASSEMBLAGES IN LABORATORY STREAMS.**  
Oregon State Univ., Corvallis. Dept. of Botany and Plant Pathology.  
For primary bibliographic entry see Field 2H.  
W91-01806

**EFFECTS OF HERBIVORE TYPE AND DENSITY ON CHEMICAL COMPOSITION OF ALGAL ASSEMBLAGES IN LABORATORY STREAMS.**  
Oregon State Univ., Corvallis. Dept. of Botany and Plant Pathology.  
For primary bibliographic entry see Field 2H.  
W91-01807

**RATES OF PROTOZOAN BACTERIVORY IN THREE HABITATS OF A SOUTHEASTERN BLACKWATER RIVER.**  
Georgia Univ., Sapelo Island. Marine Inst.  
For primary bibliographic entry see Field 2H.  
W91-01809

**PERSPECTIVE ON EL NINO AND LA NINA: GLOBAL IMPLICATIONS FOR STREAM ECOLOGY.**  
New Mexico Univ., Albuquerque. Dept. of Biology.  
For primary bibliographic entry see Field 2B.  
W91-01811

**WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1989.**  
Geological Survey, Albuquerque, NM. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01828

**WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1989.**  
Geological Survey, Lincoln, NE. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01829

**WATER RESOURCES DATA FOR OREGON, WATER YEAR 1989, VOLUME 1. EASTERN OREGON.**  
Geological Survey, Portland, OR. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01830

**PEAK-FLOW CHARACTERISTICS OF SMALL URBAN DRAINAGE ALONG THE WASATCH FRONT, UTAH.**  
Geological Survey, Salt Lake City, UT. Water Resources Div.  
For primary bibliographic entry see Field 4C.  
W91-01834

**FLOOD OF OCTOBER 1983 AND HISTORY OF FLOODING ALONG THE SAN FRANCISCO RIVER, CLIFTON, ARIZONA.**  
Geological Survey, Tucson, AZ. Water Resources Div.  
H. W. Hjalmarson.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 85-4225-B, 1990. 42p, 31 fig, 6 tab, 11 ref.

Descriptors: \*Arizona, \*Flood frequency, \*Flood peak, \*San Francisco River, Blue River, Clifton.

Clifton, Arizona, has received major damage from floods at least 12 times since the town was settled in 1870. Residents built floodwalls along the main channel of the San Francisco River, filled in floodplain areas, and raised buildings and roads in an effort to protect homes and businesses. Although the floodwalls provide protection during low and medium flows, they provide little protection during large flows. During the flood of October 1 and 2, 1983, floodwaters overtopped the floodwalls and inundated flood plains. The 2,766-square-mile basin of the San Francisco River is steep and has a large topographic relief, especially near Clifton. Intense orographic rainfall from winter storms results in rapid runoff in the San Francisco River basin. Flood routing and hydrograph analyses indicate that runoff from the southern part of the San Francisco River basin produced many large flood peaks at Clifton. (USGS)

W91-01849

**WATER RESOURCES DATA FOR IOWA, WATER YEAR 1989.**  
Geological Survey, Iowa City, IA. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01856

**WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1988.**  
Geological Survey, Charleston, WV. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01858

**WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1989.**  
Geological Survey, Lansing, MI. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01864

**MINIMUM FROUDE NUMBER AND THE EQUILIBRIUM OF ALLUVIAL SAND RIVERS.**  
Victoria Univ. of Manchester (England). Dept. of Geography.  
Y. Jia.  
Earth Surface Processes and Landforms ESPLDB,

Vol. 15, No. 3, p 199-209, May 1990. 8 Fig, 28 Ref.

Descriptors: \*Alluvial rivers, \*Channel morphology, \*Equilibrium, \*Flow, \*Froude number, \*Geomorphology, \*Model studies, \*River flow, \*Sediment load, \*Sediment transport, Channel flow, Channel stability, Channels, Computer models, Flow velocity, Hydraulic geometry, Particle size, Sand, Sedimentation, Simulation.

Rivers adjust towards an equilibrium condition, the stability of which depends on a set of controlling factors expressed by the Froude number. As alluvial river channels approach stable conditions, the Froude number of the channel flow will tend to attain a minimum value which reflects minimum bed material motion and maximum channel stability, under the constraints imposed by water discharge, sediment load, and particle size. Computer simulations for sand bed rivers show that the Froude number of the flow tends to a minimum value when the equilibrium river tends to a certain hydraulic geometry. Evidence from 57 alluvial sand and material rivers and stable channels shows that this simulated hydraulic geometry with minimum Froude number corresponds to the natural equilibrium state. The results from these simulations may be used in designing stable channels or judging the stability of alluvial channels. (Author's abstract) W91-01874

#### CHANNEL SEDIMENT VARIABILITY ALONG A RIVER: A CASE STUDY OF THE SIRET RIVER (ROMANIA).

Statuinea de Cercetari Stejarul, Piatra-Neamt (Romania). Geomorphology Lab.  
I. Ichim, and M. Radoane.  
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 3, p 211-225, May 1990. 10 fig, 4 tab, 35 ref.

Descriptors: \*Channel flow, \*Channel morphology, \*Channels, \*Geomorphology, \*Particle size, \*River sediments, \*Rivers, \*Romania, \*Sediment transport, \*Sediments, \*Siret River, \*Stream profiles, Bed load, Carpathian Mountains, Deformation, Flow channels, Mountain streams, Petrography, River beds.

The Siret River has the largest drainage basin in Romania. It gathers all the rivers from the eastern part of the Eastern Carpathians, which causes marked asymmetry of the basin. Changes in the form of the longitudinal profile and the grain size variability introduced by the Carpathian tributaries were examined. Channel sediment analyses considered the petrography, granulometry, and morphometry of the pebbles, relating these to the river bed and floodplain geometry and to some properties of the drainage basin. It was determined that the Siret River undergoes an intense regrading of its longitudinal profile, with marked aggradation between transects 24 and 26. This reflects selective accumulation of coarse material due to the massive contribution of the Carpathian tributaries. It is hypothesized that the deformation results from the failure of the river to reduce its bed elevation in its middle-lower reach to the theoretical equilibrium profile which causes the river not to attain the state of grade. This phenomenon has been continuous throughout the Holocene, resulting in the gravel sheet formation of the Pericarpian piedmont. (Author's abstract) W91-01875

#### CHANNEL AVULSION AND RIVER METAMORPHOSIS: THE CASE OF THE THOMSON RIVER, VICTORIA, AUSTRALIA.

Melbourne Univ., Parkville (Australia). Dept. of Geography.  
S. O. Brizga, and B. L. Finlayson.  
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 5, p 391-404, August 1990. 9 fig, 2 tab, 26 ref.

Descriptors: \*Avulsion, \*Channel morphology, \*Channels, \*Floodwater, \*Geomorphology, \*Meanders, \*Paleohydrology, \*Rivers, Alluvial channels, Australia, Flood plains, Hydrology, Thomson River, Victoria.

Channel avulsion occurred on the Thomson River in Victoria, Australia, in 1952 along a 12 km length of the valley. A comparison of the old and new channels reveals considerable differences in channel characteristics. The old channel was perched above the floodplain on an alluvial ridge and when bankfull capacity was exceeded, floodwaters concentrated on the lowest part of the floodplain some distance away. This is where the new channel formed. It is an incised channel with larger capacity and longer meander wavelength than the old channel and is also shorter and steeper. The new channel is subject to larger floodflows and a more variable flood regime than the old course because of the differences in the channel/floodplain relationship and channel capacity. The resulting concentration of stream power along the new course is responsible for the contrast in channel characteristics and for the more rapid meander migration. This example shows that river metamorphosis can occur without major environmental changes. Measures of channel geometry such as gradient, sinuosity, and meander wavelength cannot be used in paleohydrological work to infer climatic or other environmental changes without independent supporting evidence. Differences in channel geometry can arise simply from changes in the relationship between the channel and its floodplain. (Author's abstract) W91-01879

#### BLANKET PEAT EROSION IN A MID-WALES CATCHMENT DURING TWO DROUGHT YEARS.

University Coll. of Wales, Aberystwyth. Dept. of Geography.  
For primary bibliographic entry see Field 2J.  
W91-01881

#### INFLUENCE OF DEBRIS FLOWS ON CHANNELS AND VALLEY FLOORS IN THE OREGON COAST RANGE, U.S.A.

Washington Univ., Seattle. Dept. of Geological Sciences.  
For primary bibliographic entry see Field 2J.  
W91-01882

#### COMPARISON OF PHYTOPLANKTON ASSEMBLAGES AND ENVIRONMENTAL RELATIONSHIPS IN THREE ESTUARINE RIVERS OF THE LOWER CHESAPEAKE BAY.

Old Dominion Univ., Norfolk, VA. Dept. of Biological Sciences.  
For primary bibliographic entry see Field 2L.  
W91-01905

#### STABILITY OF PERIPHYTON AND MACROINVERTEBRATES TO DISTURBANCE BY FLASH FLOODS IN A DESERT STREAM.

Arizona State Univ., Tempe. Dept. of Zoology.  
For primary bibliographic entry see Field 2H.  
W91-01924

#### DISCHARGE-EXPORT RELATIONSHIPS IN HEADWATER STREAMS: THE INFLUENCE OF INVERTEBRATE MANIPULATIONS AND DROUGHT.

Georgia Univ., Athens. Dept. of Entomology.  
For primary bibliographic entry see Field 2H.  
W91-01925

#### MASS-BALANCE OF METALS AND IDENTIFICATION OF THEIR SOURCES IN BOTH RIVER AND FALLOUT FLUXES NEAR GDANSK BAY, BALTIC SEA.

Akademia Medyczna, Gdansk (Poland). Dept. of Analytical Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-02007

#### PHTHALATE ESTERS IN RIVERS OF THE GREATER MANCHESTER AREA, U.K.

Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-02011

## 2F. Groundwater

### VIRUS TRANSPORT AND SURVIVAL IN SATURATED AND UNSATURATED FLOW THROUGH SOIL COLUMNS.

Arizona Univ., Tucson. Dept. of Soil and Water Science.

For primary bibliographic entry see Field 5B.  
W91-01008

### AEROBIC AND ANAEROBIC DEGRADATION OF ALACHLOR IN SAMPLES FROM A SURFACE TO GROUNDWATER PROFILE.

Agricultural Research Service, Stoneville, MS. Southern Weed Science Lab.

For primary bibliographic entry see Field 5B.  
W91-01019

### MURKY STANDARDS FOR GROUNDWATER.

Pennsylvania Dept. of Environmental Resources, Harrisburg. Bureau of Hazardous Sites and Superfund Enforcement.

D. A. Brown.  
Environmental Forum ENVFEN, Vol. 7, No. 3, p 16-21, May/June 1990.

Descriptors: \*Environmental protection, \*Groundwater management, \*Groundwater pollution, \*Water pollution control, \*Water quality standards, Aquifers, Cleanup operations, Contamination, Federal jurisdiction, Legal aspects, Liability, Political aspects, Regulations, Resource Conservation and Recovery Act.

Federal groundwater policy has provided the states with incomplete guidance since it was first patched together six years ago. When the EPA started to formulate its policy in the early 1980s, it realized that none of the nine major federal environmental laws gave the agency comprehensive authority over national groundwater resources. The EPA has now proposed that protecting uncontaminated groundwater requires a different approach than one for remediating polluted aquifers. The new policy is presented in two documents: 'EPA Statement of Groundwater Principles' and 'State/Federal Relationships Options Paper, EPA Ground-Water Task Force.' While the EPA is moving away from permitting degradation either to maximum contaminant levels (MCL) or maximum contaminant level goal levels, unfortunately its new policy retains former, less strict standard in making decisions on remediating already contaminated supplies. Once adopted under Superfund and Resource Conservation and Recovery Act (RCRA), MCLs and other cleanup standards constitute not only the levels that will be deemed acceptable for cleanup, but also the limit of liability for cleanup for the persons who are responsible for creating the environmental problem. In actuality, EPA reconciles the inherent conflict between large remedy costs and cleanup standards by minimizing costs and setting standards in individual cases in a way that structures the responsible parties' liability at a level that has already taken the cost to them into consideration. By trying to place protection on an equal footing with remediation, the two recent EPA documents present a shift in how the agency presents its groundwater policy, and seem to send a message to the states that groundwater protection efforts should not rely on MCLs as a degradation ceiling. (Brunone-PTT) W91-01096

### GROUNDWATER: A REVIEW OF THE 1989 LITERATURE.

North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.  
C. T. Miller, and A. S. Mayer.  
Research Journal of the Water Pollution Control Federation JWPPAF, Vol. 62, No. 5, p 700-737, July/August 1990. 655 ref.

Descriptors: \*Groundwater, \*Groundwater management, \*Groundwater movement, \*Literature review, \*Saturated flow, \*Unsaturated flow, Biodegradation, Biological properties, Chemical interactions, Desorption, Hydrology, Monitoring,

## Field 2—WATER CYCLE

### Group 2F—Groundwater

Radon, Salinity, Sorption, Transport, Water quality.

Distinctions are made among single-, two-, and three-phase systems in this review. Single-phase systems refer to groundwater systems subjected to saturated flow conditions, whereas the two-phase and three-phase systems include groundwater systems subjected to unsaturated flow conditions, or conditions influenced by immiscible organic fluids such as petroleum products. Within the single-, two-, and three-phase system categories. Subdivisions are made among physical, chemical, or biological processes such as hydrodynamics, sorption/desorption, chemical reactions, and biodegradation. Specialized areas such as radon and radionuclide transport, facilitated transport, and saline groundwaters also are treated separately. The Rounding out this year's review, papers concerning groundwater quality monitoring, remediation, and management are discussed. (Author's abstract) W91-01178

#### CONSTRAINTS ON THE USE OF MODELS TO PREDICT THE MOVEMENT OF PESTICIDES TO GROUNDWATER.

For primary bibliographic entry see Field 5B. W91-01223

#### HYDROLYSIS OF CHLOROSTILBENE OXIDE. II. MODELING OF HYDROLYSIS IN AQUIFER SAMPLES AND IN SEDIMENT-WATER SYSTEMS.

Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab. For primary bibliographic entry see Field 5B. W91-01256

#### CHLORINATED SOLVENTS IN UK AQUIFERS.

Waterloo Univ. (Ontario). Inst. for Ground Water Research. For primary bibliographic entry see Field 5B. W91-01271

#### ECOLOGICAL CORRELATION BETWEEN ARSENIC LEVEL IN WELL WATER AND AGE-ADJUSTED MORTALITY FROM MALIGNANT NEOPLASMS.

National Taiwan Univ., Taipei. Inst. of Public Health. For primary bibliographic entry see Field 5C. W91-01292

#### DEVICE FOR IN SITU DETERMINATION OF GEOCHEMICAL TRANSPORT PARAMETERS. I. RETARDATION.

Waterloo Univ. (Ontario). Dept. of Earth Sciences. For primary bibliographic entry see Field 5B. W91-01293

#### LOGNORMAL DISTRIBUTION OF RADON CONCENTRATION IN GROUND WATER.

Ecole Polytechnique, Montreal (Quebec). For primary bibliographic entry see Field 5B. W91-01294

#### USE OF TREE-RING CHEMISTRY TO DOCUMENT HISTORICAL GROUND-WATER CONTAMINATION EVENTS.

Geological Survey, Columbia, SC. Water Resources Div. For primary bibliographic entry see Field 5B. W91-01295

#### HYDROGEOLOGIC DATABASE FOR GROUND-WATER MODELING.

Groundwater Services, Inc., Houston, TX. For primary bibliographic entry see Field 7C. W91-01298

#### PH AND REDOX BUFFERING MECHANISMS IN A GLACIAL DRIFT AQUIFER CONTAMINATED BY LANDFILL LEACHATE.

Western Michigan Univ., Kalamazoo. Center for Water Research. For primary bibliographic entry see Field 5B. W91-01300

#### HYDROGEOLOGICAL DECISION ANALYSIS: I. A FRAMEWORK.

British Columbia Univ., Vancouver. Dept. of Geological Sciences. For primary bibliographic entry see Field 6A. W91-01301

#### EXPERT TESTIMONY FOR THE PLAINTIFFS IN THE CASE THAT BROUGHT OHIO GROUND-WATER LAW INTO THE 20TH CENTURY.

Ohio State Univ., Columbus. Dept. of Geology and Mineralogy. For primary bibliographic entry see Field 6E. W91-01302

#### RELATION BETWEEN SATURATED CONDUCTIVITY AND CAPILLARY RETENTION CHARACTERISTICS.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies. S. Mishra, and J. C. Parker. Ground Water GRWAAP, Vol. 28, No. 5, p. 775-777, September/October 1990. 1 fig, 1 tab, 14 ref.

Descriptors: \*Capillary capacity, \*Groundwater movement, \*Hydraulic conductivity, \*Mathematical equations, \*Saturated flow, \*Soil water, \*Unsaturated flow, Capillary conductivity, Capillary water, Mathematical studies, Model studies.

A simple closed form equation for saturated hydraulic conductivity, has been derived using the statistical pore structure model of Maulem with van Genuchten's capillary retention relationship. Application of this equation to an experimental data set shows reasonable mean agreement between measured and predicted saturated conductivities with approximately order-of-magnitude precision in predictions. Equations which are presented provide a consistent theoretical basis for estimating both saturated and unsaturated conductivities from capillary retention characteristics, and should be useful as predictive tools in the absence of actual conductivity measurements. As such, these equations are an alternative to purely statistical models which relate soil texture to hydraulic properties. The proposed procedure should be applicable in estimating saturated/unsaturated conductivity from capillary retention characteristics when moisture retention curve and the retention parameters are indirectly generated from particle size distribution data. (Lantz-PTT) W91-01303

#### PROGRAM TO CALCULATE HYDRAULIC CONDUCTIVITY USING SLUG TEST DATA.

Idaho National Engineering Lab., Idaho Falls. For primary bibliographic entry see Field 7C. W91-01305

#### LOGGING OF SPECIAL HYDROGEOLOGICAL WELLS.

Karlova Univ., Prague (Czechoslovakia). Faculty of Science. For primary bibliographic entry see Field 7B. W91-01360

#### WHAT SHOULD BE DONE TO MITIGATE GROUNDWATER CONTAMINATION.

Academy of Natural Sciences of Philadelphia, PA. For primary bibliographic entry see Field 5G. W91-01374

#### ZINC IN POOR SANDY SOILS AND ASSOCIATED GROUNDWATER. A CASE STUDY.

Amsterdam Univ. (Netherlands). Landscape and Environmental Research Group. For primary bibliographic entry see Field 5B. W91-01450

#### ADVECTION SIMULATION BY MINIMAX-CHARACTERISTICS METHOD.

Hong Kong Polytechnic, Kowloon. Dept. of Civil and Structural Engineering. For primary bibliographic entry see Field 8B. W91-01496

#### DIMENSIONLESS STRAIGHT-TYPE LINES FOR AQUIFER TESTS.

King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Hydrogeology. Z. Sen.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 9, p. 1145-1156, September 1990. 5 fig, 1 tab, 7 ref, append.

Descriptors: \*Aquifer characteristics, \*Aquifer testing, \*Flow models, \*Groundwater movement, \*Model studies, \*Pumping tests, Drawdown, Flow equations, Hydrological regime, Nonlinear programming, Transmissivity, Turbulent flow.

Type curves for the general nonlinear flow based on the exponential flow law were derived with the application of the Boltzmann transformation to the groundwater continuity and flow-law equations. The initial and moderate portions of these curves are very significant for the estimation of aquifer parameters. Recently, nonlinear flow-type straight-line expressions were derived on the basis of exponential flow law instead of the linear Darcy law. A procedure of hypothesis testing for the flow-regime linearity has been developed. Using this procedure, it was concluded that any straight line for late time-drawdown data on semilogarithmic paper does not necessarily guarantee the accurate application of the classical Jacob methods, but confirms the flow is radial. A dimensionless time-drawdown plot should be used for the identification of flow regime. If the dimensionless time-drawdown plot for the late time-drawdown data fits a straight line with the same slope as the Jacob straight line, then the underlying flow regime is linear. Otherwise, the flow regime is nonlinear. Once the flow regime is nonlinear, the necessary equations should be applied for the estimation of parameters such as the storability, turbulence exponent, and transmissivity. The methodology has been applied successfully to field data. (Author's abstract) W91-01497

#### TWO-PHASE RELATIVE PERMEABILITY AND CAPILLARY PRESSURE OF ROUGH-WALLED ROCK FRACTURES.

Lawrence Berkeley Lab., CA. Earth Sciences Div. K. Pruess, and Y. W. Tsang. Water Resources Research WRERAQ, Vol. 26, No. 9, p. 1915-1926, September 1990. 9 fig, 52 ref. DOE Contract DE-AC03-76SF00098.

Descriptors: \*Fracture permeability, \*Geologic fractures, \*Groundwater movement, \*Model studies, \*Multiphase flow, Capillarity, Permeability, Rock properties, Wetting.

A conceptual and numerical model of multiphase flow in fractures has been developed. The void space of real rough-walled rock fractures is conceptualized as a two-dimensional heterogeneous porous medium, characterized by aperture as a function of position in the fracture plane. Portions of a fracture are occupied by wetting and nonwetting phase, respectively, according to local capillary pressure and global accessibility criteria. Phase occupancy and permeability are derived by assuming a parallel-plate approximation for suitably small subregions in the fracture plane. For log normal aperture distributions, a simple approximation to fracture capillary pressure is obtained in closed form; it resembles the typical shape of Leverett's  $j$  function. Approximations to wetting and nonwetting phase relative permeabilities are calculated by numerically simulating single phase flows separately in the wetted and nonwetted pore spaces. Illustrative examples indicate that relative permeabilities depend on the nature and range of spatial correlation between apertures. It was also observed that interference between fluid phases flowing in a fracture tends to be strong, with the

sum of wetting and nonwetting phase relative permeabilities being considerably less than 1 at intermediate saturations. (Author's abstract) W91-01511

#### INTERBED STORAGE CHANGES AND COMPACTION IN MODELS OF REGIONAL GROUNDWATER FLOW.

Geological Survey, Tucson, AZ.

S. A. Leake.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 1939-1950, September 1990. 8 fig, 1 tab, 32 ref.

**Descriptors:** \*Compaction, \*Groundwater movement, \*Land subsidence, \*Model studies, \*Pumping head, \*Storage coefficient, \*Subsidence, California, Confined aquifers, Flow models, Groundwater storage, Mathematical models, Pumping, Storage equation.

Water released from permanent compaction of compressible fine-grained interbeds within confined aquifers may be a significant source of pumped water. Permanent or inelastic compaction of the interbeds occurs when head declines from pumping cause the effective stress or grain-to-grain load to exceed the elastic limits of the interbeds. As a result, the grains in the interbeds rearrange and excess water is expelled. The amount of inelastic compaction generally is proportional to the increase in effective stress and the decrease in head. A common approach for the simulation of elastic and inelastic compaction in groundwater flow models is to assume that head changes in the aquifer result in instantaneous storage changes in the compressible interbeds. A term is added to the groundwater flow equation to account for the storage changes. Changes in specific storage may be computed explicitly from the results at the previous time step in the finite difference formulation of the groundwater flow equation. A better approach is to implicitly apportion storage changes between elastic and inelastic components within a time step. If storage changes cannot be considered to occur instantaneously with change in head in the aquifer, another approach is taken. Equations for horizontal flow in the aquifer are coupled with equations for vertical flow in the compressible interbeds to simulate flow in half a representative doubly draining interbed. Storage changes and compaction are calculated for the representative half thickness and are extrapolated to the entire thickness of all interbeds within each cell. This approach was applied to an existing model of groundwater flow in the Central Valley of California. The simulation demonstrated that solving coupled systems of equations is feasible for a regional flow model. (Author's abstract) W91-01513

#### SOLVING GROUNDWATER FLOW PROBLEMS BY CONJUGATE-GRADIENT METHODS AND THE STRONGLY IMPLICIT PROCEDURE.

Geological Survey, Lakewood, CO.

M. C. Hill.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 1961-1969, September 1990. 1 fig, 2 tab, 33 ref.

**Descriptors:** \*Computer models, \*Flow models, \*Groundwater movement, \*Model studies, Computers.

The performance of the preconditioned conjugate-gradient method with three preconditioners for solving groundwater flow problems was compared with the strongly implicit procedure (SIP) using a scalar computer. The preconditioners considered are the incomplete Cholesky (ICCG) and the modified incomplete Cholesky (MICCG), which require the same computer storage as SIP as programmed for a problem with a symmetric matrix, and a polynomial preconditioner (POLCG), which requires less computer storage than SIP. Although POLCG is usually used on vector computers, it was included because of its small storage requirements. Published comparisons of the solvers were evaluated, all four solvers were compared for the first time, and new test cases were examined to

provide a more complete basis by which the solvers can be judged for typical groundwater flow problems. Based on nine test cases, the following conclusions were reached: (1) SIP is actually as efficient as ICCG for some of the published, linear, two-dimensional test cases that were reportedly solved much more efficiently by ICCG; (2) SIP is more efficient than other published comparisons would indicate when common convergence criteria are used; and (3) for problems that are three-dimensional, nonlinear, or both, and for which common convergence criteria are used, SIP is often more efficient than ICCG, and is sometimes more efficient than MICCG. (Author's abstract) W91-01515

#### GEOCHEMICAL MODELING OF THE MADISON AQUIFER IN PARTS OF MONTANA, WYOMING, AND SOUTH DAKOTA.

Geological Survey, Reston, VA.

For primary bibliographic entry see Field 2K.

W91-01517

#### MOMENTARY INSTABILITY OF A SATURATED POROUS LAYER WITH A TIME-DEPENDENT TEMPERATURE DISTRIBUTION, AND THE MOST UNSTABLE DISTURBANCE.

Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.

For primary bibliographic entry see Field 5B.

W91-01518

#### STREAM FUNCTIONS AND EQUIVALENT FRESHWATER HEADS FOR MODELING REGIONAL FLOW OF VARIABLE-DENSITY GROUNDWATER. 1. REVIEW OF THEORY AND VERIFICATION.

Texas Univ. at Austin. Bureau of Economic Geology.

R. K. Senger, and G. E. Fogg.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 2089-2096, September 1990. 6 fig, 25 ref.

**Descriptors:** \*Flow equations, \*Geohydrology, \*Groundwater movement, \*Model studies, \*Path of pollutants, \*Saline water intrusion, Boundary conditions, Confined aquifers, Errors, Hydraulic gradient, Mathematical models, Variable density.

Steady state flow of variable-density groundwater was simulated using equivalent freshwater heads and stream functions. On the basis of previously published work, fluids with different fluid densities are replaced by one hypothetical fluid, and singularities are introduced along interfaces where the actual fluids change densities. The basic flow equation describing variable-density flow, written in terms of equivalent freshwater head, was used to derive the corresponding stream function equation and associated boundary conditions. Neumann boundary conditions for the stream function equation can be determined from gradients of equivalent freshwater heads along the boundary. Stream functions provide a direct representation of the groundwater flow pattern and flow rates where fluid densities vary in space. In comparison, equivalent freshwater heads and fluid densities describe the two driving forces, hydraulic gradient and buoyancy force, but head gradients do not necessarily describe the flow direction of variable-density groundwater in isotropic media. Comparison of the finite element formulations indicated that potential errors in the centroid-consistent velocity calculation based on the stream function solution can be expected to be smaller than those in the velocity calculation based on the head solution for cross-sectional flow models, because discretization in the vertical direction is typically finer than in the horizontal direction. The approach of using stream functions and equivalent freshwater head for simulating groundwater flow of variable density fluid is demonstrated using a cross-sectional study of seawater intrusion into a confined aquifer as an example. (See also W91-01525) (Author's abstract) W91-01524

#### STREAM FUNCTIONS AND EQUIVALENT FRESHWATER HEADS FOR MODELING RE-

#### GIONAL FLOW OF VARIABLE-DENSITY GROUNDWATER. 2. APPLICATION AND IMPLICATIONS FOR MODELING STRATEGY.

Texas Univ. at Austin. Bureau of Economic Geology.

R. K. Senger, and G. E. Fogg.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 2097-2106, September 1990. 7 fig, 1 tab, 25 ref.

**Descriptors:** \*Convection, \*Flow models, \*Geohydrology, \*Groundwater movement, \*Model studies, \*Path of pollutants, \*Surface-groundwater relations, Boundary conditions, Brines, Hydraulic properties, Saline water, Uncertainty.

Stream functions and equivalent freshwater heads were used to simulate steady state flow of variable-density groundwater in a regional, cross-sectional flow model through the Palo Duro Basin, Texas, where fluid densities vary between 1.0 and 1.15 g/cm<sup>3</sup>. Centroid-consistent velocities computed from the stream function solution allow a more precise interpretation of local flow patterns in cross-sectional models than those from the head solution. Effects of significant fluid density variation on the regional groundwater flow pattern were studied by comparing simulation results that incorporate spatially varying, time-invariant densities with those that assume uniform density. Modeling shows that the regional groundwater flow pattern in the Palo Duro Basin is not significantly affected by variations in fluid densities, indicating that the topographically driven flow component dominates buoyancy forces associated with dense brines. An exception is near the eastern boundary where high fluid densities cause stronger downward flow. However, simulated equivalent freshwater heads in the variable-density model differ significantly from simulated heads in the freshwater density model, which is important for model calibration. In addition to the problems of hydraulic parameter and boundary condition uncertainties, modeling strategies for regional flow systems require consideration of uncertainties associated with fluid density and evaluation of equivalent freshwater head data. (See also W91-01524) (Author's abstract) W91-01525

#### TIDAL DYNAMICS OF THE WATER TABLE IN BEACHES.

Sydney Univ. (Australia). Ocean Technology Group.

P. Nielsen.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 2127-2134, September 1990. 8 fig, 2 tab, 10 ref.

**Descriptors:** \*Beaches, \*Model studies, \*Surface-groundwater relations, \*Tidal effects, \*Water level, \*Water table, Boundary conditions, Field tests, Mathematical models, Slopes, Tides.

Tidal motions of the water table height inside a sloping beach were investigated via field measurements and theoretical considerations. Only the movements forced by the tide were considered, so a beach with negligible wave activity was chosen for the field measurements. The data show that even in the absence of precipitation the time averaged inland water table stands considerably above the mean sea level. Also the water table at a fixed point inside the beach is far from sinusoidal even though its variation is forced by an essentially sinusoidal tide. This effect is due to the boundary condition along the sloping beach face which acts as a highly nonlinear filter. The observed behavior of the water table is explained in terms of perturbation extensions to the classical 'deep aquifer solution'. One extension deals with the nonlinearity in the interior, the other with the boundary condition at the sloping beach face. (Author's abstract) W91-01528

#### BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 1. EXPERIMENTAL INVESTIGATION.

Princeton Univ., NJ. Dept. of Computer Science.

## Field 2—WATER CYCLE

### Group 2F—Groundwater

S. W. Taylor, and P. R. Jaffe.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 2153-2159, September 1990. 7 fig, 2 tab, 23 ref. USGS Grant 14-08-0001-G1136.

Descriptors: \*Artificial recharge, \*Biofilms, \*Clogging, \*Injection wells, \*Permeability, \*Physical properties, \*Porous media, Bacteria, Biomass, Experimental data, Laboratory methods, Model studies, Piezometric head, Plugging.

An experimental investigation was conducted to quantify the permeability reduction caused by enhanced biological growth in a porous medium. Studies were conducted using sand-packed column reactors for which variations in piezometric head, substrate concentration, and biomass measured as organic carbon were monitored in space and time. Methanol was used as a growth substrate. Permeability reductions by factors of order 0.001 were observed. The data show that a limit on permeability reduction exists, having a magnitude of 0.0005 in the present study. The limit on permeability reduction and existence of high densities of bacteria in substrate depleted zones are explained with an open pore model. Permeability reduction correlated well with biomass density for values less than 0.4 mg/cu cm, and exhibited independence at higher densities. (See also W91-01532 and W91-01533) (Author's abstract)

W91-01531

**BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 2. PERMEABILITY.** Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.

S. W. Taylor, P. C. D. Milly, and P. R. Jaffe. Water Resources Research WRERAQ, Vol. 26, No. 9, p 2161-2169, September 1990. 10 fig, 17 ref. USGS Grant 14-08-0001-G1136.

Descriptors: \*Artificial recharge, \*Biofilms, \*Clogging, \*Injection wells, \*Model studies, \*Permeability, \*Porous media, Biomass, Comparison studies, Mathematical models, Physical properties, Porosity.

Growth of a biofilm in a porous medium reduces the total volume and the average size of the pores. The change in the pore size distributions is easily quantified when certain geometric assumptions are made. Existing models of permeability or of relative permeability can be manipulated to yield estimates of the resulting reduction in permeability as a function of biofilm thickness. The associated reductions in porosity and specific surface can be estimated as well. Based on a sphere model of the medium, the Kozeny-Carman permeability model predicts physically realistic results for this problem. Using a cut-and-random-rejoin-type model of the medium, the permeability model of Childs and Collis-George yields qualitatively reasonable results for this problem, as does a generalization of the relative permeability model of Muallem. Permeability models of Kozeny-Carman and of Millington and Quirk lead to unrealistic results for a cut-and-random-rejoin-type medium. The Childs and Collis-George and the Muallem models predict that the permeability reduction for a given volume of biomass is greatest when the porous medium has uniform pore sizes. (See also W91-01531 and W91-01532) (Author's abstract)

W91-01532

**BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 3. DISPERSIVITY AND MODEL VERIFICATION.** Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.

S. W. Taylor, and P. R. Jaffe. Water Resources Research WRERAQ, Vol. 26, No. 9, p 2171-2180, September 1990. 9 fig, 3 tab, 26 ref. USGS Grant 14-08-0001-G1136.

Descriptors: \*Artificial recharge, \*Biofilms, \*Clogging, \*Dispersivity, \*Injection wells, \*Model studies, \*Physical properties, \*Porous media, Experimental data, Least squares method, Mathematical models, Permeability, Porosity, Solute transport, Tracers.

The change in dispersivity resulting from the growth of a biofilm in a porous medium was derived from an existing model of dispersivity and a cut-and-random-rejoin-type model of the pore geometry. The change in dispersivity due to a biofilm was also estimated from experimental data. Tracer experiments were conducted in biofilm column reactors and dispersion coefficients estimated by solving the inverse solute transport problem by nonlinear, least squares regression. Due to the presence of the biofilm in the porous media, solute flux into the biofilm is an important transport process and was given special attention. Both the dispersivity model and experimentally estimated dispersivities show order of magnitude increases in dispersivity as a result of significant biofilm growth. The models for the biofilm-affected permeability, porosity, and specific surface derived in a companion paper were verified using data from biofilm column reactors. These models were used to determine parameters for an equation describing the transport of substrate in the experimental columns. Numerical simulations were performed and compared to observed substrate data. Results show that the models for permeability and porosity can be used to make estimates of these parameters, while the model for specific surface appears to be inadequate. (See also W91-01531 and W91-01532) (Author's abstract)

W91-01533

**SUBSTRATE AND BIOMASS TRANSPORT IN A POROUS MEDIUM.**

State Univ. of New York at Buffalo. Dept. of Civil Engineering.

S. W. Taylor, and P. R. Jaffe.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 2181-2194, September 1990. 12 fig, 1 tab, 33 ref.

Descriptors: \*Aquifers, \*Artificial recharge, \*Bacteria, \*Biofilms, \*Biomass, \*Clogging, \*Injection wells, \*Model studies, \*Porous media, \*Solute transport, Dispersivity, Finite element method, Groundwater recharge, Mathematical models, Permeability, Porosity, Pumping rates.

A model describing the transport of substrate and biomass in porous media was formulated which accounts for the transport, growth and decay of biomass suspended in the water phase and attached to the solid matrix as a biofilm. Interphase transport of biomass between the water phase and attached biofilm phase due to fluid mechanical shear and filtration was also considered. Special attention is given to changes in the porosity, permeability, and dispersivity resulting from the biofilm altering the microscopic geometry of the pore space. A numerical solution to the governing equations was obtained by the finite element method. The model was calibrated and verified against experimental data. The model was applied to the problem of aquifer clogging during the injection of water containing a growth-limiting substrate to assess the effects of pulsed substrate loading, flow rate, and flow duration on the clogging of porous media by biomass. Results from numerical experiments conducted with the model suggest the following: (1) Pulsed substrate loading does little to mitigate aquifer clogging for one-dimensional flow, but for radial flow from an injection well source, pulsing is expected to result in significantly less clogging. (2) Reduced substrate loading and increased pumping duration minimizes aquifer clogging. (3) Reduced substrate loading and increased pumping rate is most effective in minimizing aquifer clogging. (Author's abstract)

W91-01534

**EVALUATING GROUND-WATER VULNERABILITY TO PESTICIDES.**

Woodward-Clyde Consultants, Oakland, CA.

For primary bibliographic entry see Field 5B.

W91-01558

**PREDICTING WELL DRAWDOWN DURING PROLONGED PUMPING.**

Westinghouse Environmental and Geotechnical Services, Cary, NC.

For primary bibliographic entry see Field 4B.

W91-01682

**SPATIAL AND TEMPORAL PATTERNS IN THE HYDROGEOCHEMISTRY OF A POOR FEN IN NORTHERN WISCONSIN.**

Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.

For primary bibliographic entry see Field 2H.

W91-01720

**STUDY OF AQUATIC COMMUNITY DYNAMICS IN A KARSTIC SYSTEM BY THE USE OF ARTIFICIAL SUBSTRATES.**

Lyon-1 Univ., Villeurbanne (France). Lab. d'Hydrobiologie et Ecologie Souterraines.

For primary bibliographic entry see Field 2H.

W91-01766

**WELL LOCATION IN CAPTURE ZONE DESIGN USING SIMULATION AND OPTIMIZATION TECHNIQUES.**

Connecticut Univ., Storrs. Environmental Research Inst.

For primary bibliographic entry see Field 5G.

W91-01778

**SOURCE OF GROUND WATER IN THE DESERTS OF NORTHERN CHILE: EVIDENCE OF DEEP CIRCULATION OF GROUND WATER FROM THE ANDES.**

Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.

M. Magaritz, R. Aravena, H. Pena, O. Suzuki, and A. Grilli.

Ground Water GRWAAP, Vol. 28, No. 4, p 513-517, July/August 1990. 5 fig, 16 ref.

Descriptors: \*Geohydrology, \*Groundwater basins, \*Groundwater movement, \*Groundwater recharge, Andes Mountains, Chile, Geologic fractures, Groundwater dating, Saline groundwater.

Isotopic, chemical and geologic evidence and temperature measurements support the hypothesis of a regional ground-water flow system in the Pampa del Tamarugal, Chile, basin associated with recharge areas located in the higher part of the Andes region. The discharge of this flow system should occur as fracture flow and/or flow through the volcanic units and is suspected to be along faults situated at the foothills of the Andes and in the desert belt along the central valley. Some of the groundwaters located in the Pica and Canchones area are pre-Holocene in age, but most of the groundwaters located in the central part of the basin are younger and recharged during the Holocene. (14)C measurements in dissolved inorganic carbon were used to estimate groundwater residence times. Generally, the electric conductivity values increase from the eastern to the western part of the basin. Groundwater temperature distribution also identified the circulation of deep groundwater. (Miller-PTT)

W91-01779

**GEOELECTRICAL INVESTIGATION FOR GROUND WATER IN CRYSTALLINE TERRAINS OF CENTRAL BAHIA, BRAZIL.**

Universidade Federal do Rio Grande do Norte, Natal (Brazil). Dept. de Fisica.

W. E. Medeiros, and O. A. de Lima.

Ground Water GRWAAP, Vol. 28, No. 4, p 518-523, July/August 1990. 7 fig, 1 tab, 16 ref.

Descriptors: \*Aquifer testing, \*Brazil, \*Geohydrology, \*Geologic fractures, \*Geophysical exploration, \*Groundwater movement, \*Mapping, Algorithms, Crystalline rocks, Data acquisition, Data interpretation, Dry wells, Electrical well logging, Groundwater, Resistivity.

A practical procedure was evaluated for acquisition and representation of electrical resistivity data, including a two-dimensional methodology for quantitative structural interpretation. This technique was combined with Schlumberger vertical electrical soundings (VES) and electrical well logs

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for a comprehensive evaluation of the subsurface hydrological conditions of fractured crystalline aquifers of the Itabera area, Bahia state, Brazil. The apparent resistivity sections constructed from partial electrical sounding measurements taken at a closely spaced interval along a traverse were interpreted using a finite-difference algorithm. This scheme allowed detailed description of the lateral and vertical extent of fractured aquifers and some of their hydrogeophysical characteristics. The results of a case study from Bahia state compare satisfactorily with available geophysical logs and production data of existing wells. (Miller-PTT) W91-01780

**LABORATORY STUDIES OF THE FLOW OF SOME ORGANIC SOLVENTS AND THEIR AQUEOUS SOLUTIONS THROUGH BENTONITE AND KAOLIN CLAYS.**  
General Motors Research Labs., Warren, MI. Environmental Science Dept.  
For primary bibliographic entry see Field 5B. W91-01781

**NATURAL BIOREMEDIATION OF ORGANIC CONTAMINANTS IN GROUND WATER: CLIFFS-DOW SUPERFUND SITE.**  
Dow Chemical Co., Midland, MI. Environmental Sciences Research Lab.  
For primary bibliographic entry see Field 5B. W91-01782

**CAUSES OF SOIL SALINIZATION: 2. A BASIN IN EAST-CENTRAL ALBERTA, CANADA.**  
Alberta Agriculture, Lethbridge.  
For primary bibliographic entry see Field 2G. W91-01783

**ELUCIDATING GROUND-WATER FLOW PATHS IN A DESERT TERRANE BY GEO-CHEMICAL METHODS.**  
Purdue Univ., Lafayette, IN. Dept. of Earth and Atmospheric Sciences.  
S. J. Fritz, H. J. Lopez, and M. P. Wilson.  
Ground Water GRWAAAP, Vol. 28, No. 4, p 551-558, July/August 1990. 7 fig, 2 tab, 21 ref. National Park Service Contract No. CX702920018.

Descriptors: \*Deserts, \*Geochemistry, \*Geohydrology, \*Groundwater movement, \*Groundwater recharge, \*Springs, \*Texas, \*Water chemistry, \*Arid lands, \*Carbon radioisotopes, \*Precipitation, \*Stable isotopes, \*Tritium.

Four wells and six perennial springs located in The Big Bend National Park were sampled and analyzed to determine recharge sources for the springs which discharge along banks of arroyos incised in alluvial pediment lying about 900 meters below the uplands of the Chisos Mountains. The waters total dissolved solids and calcite saturation indices increase with decreasing altitude, suggesting recharge from the Chisos uplands. Temperature, dissolved oxygen, delta O18, tritium and Carbon-14 data indicate a significant recharge component to springs occurs by infiltration of infrequent precipitation falling on the arid alluvial lowlands. This water percolates through the soil zone to aquifers (essentially calcitic hardpans) which function as horizons which channel the water laterally toward discharge in springs. The springs recharge-to-discharge paths are short with flow being slow enough to reflect seasonal temperature differences of greater than 12 C, yet recent enough to contain post-bomb spikes of tritium and Carbon-14. (Author's abstract) W91-01784

**INDICATORS OF CHEMICAL POLLUTION FROM SEPTIC SYSTEMS.**  
Geraghty and Miller, Inc., Raleigh, NC.  
For primary bibliographic entry see Field 5A. W91-01785

**GROUND-SURFACE DELINEATION OF FRACTURES OVER MINED-OUT OPENINGS USING CARBON DIOXIDE EMISSIONS.**

Idaho Univ., Moscow. Coll. of Mines and Earth Resources.  
For primary bibliographic entry see Field 5G. W91-01787

**MEASUREMENT AND INTERPRETATION OF LOW LEVELS OF DISSOLVED OXYGEN IN GROUND WATER.**  
Geological Survey, Menlo Park, CA.  
For primary bibliographic entry see Field 7B. W91-01788

**FIELD EVALUATION OF IN-SITU BIODEGRADATION OF CHLORINATED ETHENES: PART I. METHODOLOGY AND FIELD SITE CHARACTERIZATION.**  
Stanford Univ., CA. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5G. W91-01789

**MODELING ORGANIC CONTAMINANT SORPTION IMPACTS ON AQUIFER RESTORATION.**  
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.  
For primary bibliographic entry see Field 5B. W91-01827

**WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1989.**  
Geological Survey, Albuquerque, NM. Water Resources Div.  
For primary bibliographic entry see Field 7C. W91-01828

**WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1989.**  
Geological Survey, Lincoln, NE. Water Resources Div.  
For primary bibliographic entry see Field 7C. W91-01829

**GROUND-WATER RESOURCES OF THE ARKANSAS RIVER BASIN IN ARKANSAS.**  
Geological Survey, Little Rock, AR. Water Resources Div.  
J. M. Kilpatrick, and A. H. Ludwig.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-725, 1990. 45p, 12 fig, 34 ref.

Descriptors: \*Arkansas, \*Geohydrology, \*Groundwater, \*Groundwater availability, \*Groundwater resources, \*Water quality, \*Water resources data, \*Arkansas River, \*Water use.

The Arkansas River basin in Arkansas lies almost entirely within the Interior Highlands physiographic division. The Interior Highlands consist of hilly to mountainous terrain underlain by sandstone, shale, limestone, and dolomite. That part of the basin southeast of Little Rock lies within the Gulf Coastal Plain and is characterized by flat to hilly topography. Significant water-yielding units within the Arkansas River basin include subsurface Paleozoic units such as the Eminence and Potosi Dolomites, the Gasconade Dolomite, and the Van Buren Formations, and Roubidoux Formation as well as outcrops of Paleozoic rocks, the Sparta Sand, and Quaternary deposits. The quality of groundwater withdrawn from the various aquifers in the study area is generally suitable for most uses, although commonly very hard and highly mineralized. Only the Sparta Sand yields a soft, less mineralized water. Yields from the different water-bearing units are highly variable. Several of the subsurface Paleozoic rocks rarely yield more than 10 gal/min. In the Coastal Plain, the Sparta Sand and the Quaternary deposits yield as much as 2,000 and 2,500 gal/min, respectively. Several studies have indicated substantial bacterial contamination of both wells and springs in this part of the study area. Also, nitrate concentrations that exceed U.S. Environmental Protection Agency primary drinking water standards occur in some areas. (USGS) W91-01835

**GROUND-WATER FLOW IN THE GULF COAST AQUIFER SYSTEMS, SOUTH-CENTRAL UNITED STATES—A PRELIMINARY ANALYSIS.**

Geological Survey, Austin, TX. Water Resources Div.  
A. K. Williamson, H. F. Grubb, and J. S. Weiss.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4071, 1990. 124p, 33 fig, 5 tab, 140 ref.

Descriptors: \*Groundwater, \*Groundwater movement, \*Hydrologic data, \*Water resources data, \*Computer models, \*Gulf Coast Aquifer System, \*Pumpage, \*Recharge, \*Regional analysis, \*Simulation, \*Topography, \*Vertical flow, \*Water table.

A major objective of the Gulf Coast Regional Aquifer-System Analysis is to use digital models of regional groundwater flow systems to develop better understanding and to improve management of the resource. Modeling is used to synthesize information about the aquifer systems and to test hypotheses about the relative importance of the components of the systems. The 290,000-sq mile study area in the Gulf of Mexico Coastal Plain includes the Mississippi embayment, Gulf Coastal Plain of Texas, and the Continental Shelf that are underlain by deposits of Tertiary and younger age, which contain fresh and saline water. A 10-layer, finite-difference, variable density model, with blocks 10 miles on a side, was used to simulate groundwater flow before development and in 1980, assuming steady-state conditions. Preliminary results indicate that the major factors controlling predevelopment regional flow are the topography, land-surface outcrop pattern, and geometry of aquifers and confining units. Geologic structure and the distribution of precipitation were less significant factors. The density of saline water in the deeper parts of the aquifer system probably has a substantial effect on regional groundwater flow that extends into the freshwater part of the system. Variable water density may be a significant driving force that transports salt great distances in many directions, including updip. The distribution and rates of regional recharge and discharge have been substantially changed by development. Groundwater pumping in 1980 was about five times the value of predevelopment regional recharge. About 80% of the pumping was supplied from increased regional recharge. Also resistance to vertical flow caused by many fine-grained beds within the permeable zones can be as important as resistance caused by regional confining units. (USGS) W91-01838

**ASSESSMENT OF HYDROLOGIC AND HYDROGEOLOGIC DATA AT CAMP LEJEUNE MARINE CORPS BASE, NORTH CAROLINA.**  
Geological Survey, Raleigh, NC. Water Resources Div.  
D. A. Harned, O. B. Lloyd, and M. W. Treece.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4096, 1989. 64p, 20 fig, 2 tab, 19 ref.

Descriptors: \*Camp Lejeune, \*Groundwater movement, \*Hydrogeology, \*Hydrologic data, \*North Carolina, \*Water level, \*Water resources data, \*Water use, \*Castle Hayne Aquifer, \*Coastal plains.

The U.S. Geological Survey, in cooperation with the U.S. Marine Corps, is studying the groundwater resources of the Marine Corps Base at Camp Lejeune, North Carolina, and is constructing a groundwater flow model of the area. Water use by the Base increased from about 4 million gal/day in 1941 to about 7 million gal/day in 1986. In the last decade, water demand has not increased substantially. The Castle Hayne aquifer is the source of water for the Base. The aquifer, which lies between 50 and 300 ft below the Base, is composed of a series of sand and limestone beds. Contour maps of water levels show that the New River is a major discharge area for the Castle Hayne, as is the Atlantic Ocean. The top of the aquifer ranges from about 20 ft above sea level in the northern

## Field 2—WATER CYCLE

### Group 2F—Groundwater

part of the area to about 40 ft below sea level in the southeastern part. Thin and discontinuous clay beds, less than 30 ft thick, compose about 15% to 24% of the section, indicating that the aquifer is in a leaky, confined aquifer system. Well-acceptance tests indicate a mean specific capacity of 8.8 gal/min/ft of drawdown. The mean transmissivity value estimated from specific capacities is 9,900 sq ft/day. The mean estimated hydraulic conductivity is 48 ft/day. (USGS) W91-01840

#### HYDROGEOLOGY OF AQUIFERS IN CRETACEOUS AND YOUNGER ROCKS IN THE VICINITY OF ONSLOW AND SOUTHERN JONES COUNTIES, NORTH CAROLINA.

Geological Survey, Raleigh, NC. Water Resources Div.  
W. L. Lyke, and M. D. Winner.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4128, 1990. 49p, 12 fig, 3 tab, 21 ref.

Descriptors: \*Aquifers, \*Coastal plains, \*Geohydrology, \*Groundwater, \*Hydrologic data, \*North Carolina, \*Water resources data, Cross-sections, Hydrogeology, Maps.

Unconsolidated sediments in Onslow and Jones Counties, North Carolina overlie crystalline basement rocks and range in thickness from about 700 ft to more than 1,800 ft, thickening toward the east. This material is composed of permeable sand and limestone interlayered with relatively impermeable clay and silt beds. Sediments are divided into two groups: aquifers in Quaternary, and Tertiary-aged rocks and aquifers in Cretaceous-aged rocks. Aquifers in the Cretaceous rocks provide most of the groundwater for public supplies and are the focus of this report. The aquifers in Cretaceous rocks are the Pee Dee, Black Creek, upper Cape Fear, and lower Cape Fear aquifers, which are composed of beds or groups of beds of sand and gravel. Each aquifer is overlain by a clay and silt bed, that impedes the flow of water between aquifers. The thickness of Cretaceous hydrogeologic units ranges from about 700 ft to more than 1,300 ft. Hydrogeologic units are correlated using 60 geophysical logs and accompanying drillers' logs along with water level and water quality data. Three hydrogeologic sections demonstrate the continuity of the aquifers and confining units, show water levels and chloride concentration in water from test intervals, and delineate where chloride concentration in water exceeds 250 mg/L within each aquifer. Maps of each aquifer in Cretaceous rocks show altitude of its top, thickness, sand percentage, and the transition from freshwater to saltwater. Maps of the confining units show thickness and sand percentage of each. (USGS) W91-01841

#### WATER RESOURCES OF CODINGTON AND GRANT COUNTIES, SOUTH DAKOTA.

Geological Survey, Huron, SD. Water Resources Div.  
D. S. Hansen.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4147, 1990. 47p, 25 fig, 8 tab, 18 ref.

Descriptors: \*Groundwater, \*Hydrologic data, \*North Dakota, \*Water resources data, Bedrock aquifers, Glacial aquifers, Groundwater recharge, Water quality, Water use.

The primary sources of surface water in Codington and Grant Counties are Lakes Kampeska and Pelican and numerous potholes in western Codington County. Seasonal variations in streamflow and lake levels are directly related to seasonal variations in precipitation and evapotranspiration. Dissolved-solids concentrations in water from streams and lakes increase as stream discharge decreases and lake levels decline. Seven aquifers in glacial-outwash deposits and two bedrock aquifers were delineated in Codington and Grant Counties. The extent of the outwash aquifers ranges from 30 sq mi for the Antelope Valley aquifer to 860 sq mi for

the Altamont aquifer. The average thickness of the glacial aquifers ranges from 20 ft for the Prairie Coteau to 63 ft for the Revillo. The Big Sioux and Antelope Valley aquifers are less than 10 ft below land surface. The Veblen, Prairie Coteau, and the Lonesome Lake aquifers are less than 380 ft below land surface. The Revillo and Altamont aquifers are less than 668 ft below land surface. Reported well yields are as much as 800 gal/min for the Big Sioux, Antelope Valley, and Prairie Coteau aquifers. Predominant ions are calcium and bicarbonate in water from the Big Sioux, Antelope Valley, Prairie Coteau, Veblen, Revillo, and Lonesome Lake aquifers. Sulfate also is predominant in water from the Veblen aquifer. Average dissolved-solids concentrations in water from the aquifers range 350 to 2,120 mg/L. The two bedrock aquifers delineated are the Dakota and granite wash. The water level has declined 10 ft from 1958 to 1985. Predominant ions in water from the Dakota and granite wash aquifers are sodium and sulfate. (USGS) W91-01842

#### SIMULATION OF GROUND-WATER FLOW IN AQUIFERS IN CRETACEOUS ROCKS IN THE CENTRAL COASTAL PLAIN, NORTH CAROLINA.

Geological Survey, Raleigh, NC. Water Resources Div.  
J. L. Eimers, W. L. Lyke, and A. R. Brockman.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4153, 1990. 101p, 43 fig, 11 tab, 41 ref.

Descriptors: \*Aquifer characteristics, \*Coastal plains, \*Geohydrology, \*Groundwater movement, \*Mathematical models, \*North Carolina, Groundwater management, Hydrogeologic units.

The principal water supply aquifers in Cretaceous rocks in the central Coastal Plain of North Carolina are the Pee Dee, Black Creek, and upper Cape Fear aquifers. Groundwater withdrawals from this aquifer system have increased from about 0.25 million gal/day in 1910 to more than 30 million gal/day in 1986, causing water level declines of as much as 160 ft. The maximum rate of water level decline has been about 11 ft/yr in the Black Creek aquifer. A quasi-three dimensional groundwater flow model was constructed and calibrated for the period 1900 to 1986 to simulate this decline and to provide a means to estimate the effects of future pumping. Comparisons of 1,867 observed and computed water levels were made at 323 well sites. The average difference between computed and observed water levels is -1 ft. About 68% of the differences between computed and observed water levels falls in the range from -21.0 to 21.0 ft. Net flow across the top of the aquifers in Cretaceous rocks has changed from a discharge of 2 million gal/day in 1900 to a recharge of 18 million gal/day in 1986. The model was used to simulate the effects of two pumping scenarios on water levels through 1991. For these simulations, the model indicated additional declines of 10 and 30 ft. (USGS) W91-01843

#### HYDROGEOLOGIC, WATER-LEVEL, AND WATER-QUALITY DATA FROM MONITORING WELLS AT THE U.S. MARINE CORPS AIR STATION, CHERRY POINT, NORTH CAROLINA.

Geological Survey, Raleigh, NC. Water Resources Div.  
For primary bibliographic entry see Field 5B. W91-01844

#### SUMMARY OF PUBLIC WATER-SUPPLY WITHDRAWALS AND GEOHYDROLOGIC DATA FOR THE LOWER CONNECTICUT RIVER VALLEY FROM WINDSOR TO VERNON, VERMONT.

Geological Survey, Bow, NH. Water Resources Div.  
J. Ayotte.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 88-341, 1989. 35p, 4 fig, 3 tab, 16

ref.

Descriptors: \*Connecticut River Valley, \*Geohydrologic data, \*Geohydrology, \*Groundwater resources, \*Public water supply, \*Vermont, \*Water resources data, Groundwater, Hydrology, Seismic reflection, Seismic refraction, Stratified-drift aquifers, Stratigraphic logs, Water resources, Well surveys.

Public water supply withdrawal data and geohydrologic data were collected along a 50 mile segment of the Connecticut River valley from Windsor to Vernon, Vermont. An inventory of wells indicates that domestic groundwater supplies come primarily from bedrock, whereas public water supplies are derived from discontinuous, glacial sand and gravel deposits. Self supplied industries generally use surface water supplies. Data from eight seismic-refraction surveys, and from a seismic-reflection survey along this 50-mile reach of the Connecticut River, were compared with stratigraphic information from 217 drillers' logs. Stratified-drift deposits range from 0 to 270 ft and average about 65 ft. Stratigraphic information from drillers' logs and seismic-reflection records show that predominantly fine-grained stratified drift fills the valley and that coarse sand and gravel deposits exist discontinuously within this area. (USGS) W91-01845

#### GEOLOGY AND GROUND-WATER RESOURCES OF THE MEMPHIS SAND IN WESTERN TENNESSEE.

Geological Survey, Nashville, TN. Water Resources Div.  
W. S. Parks, and J. K. Carmichael.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4182, 1990. 30p, 9 fig, 2 plates, 4 tab, 20 ref.

Descriptors: \*Aquifers, \*Geohydrology, \*Groundwater, \*Groundwater availability, \*Tennessee, \*Water quality, \*Water resources data, Aquifer characteristics, Geologic formations, Geology, Groundwater movement, Groundwater recharge, Memphis Aquifer, Memphis Sand, Potentiometric level, Stratigraphy, Structural geology, Water level fluctuations, Water supply development.

The Memphis Sand of the Claiborne Group of Tertiary age underlies approximately 7,400 sq mi in western Tennessee. The formation consists primarily of a thick body of very fine to very coarse sand that contains subordinate lenses or beds of clay and silt at various horizons. The Memphis Sand ranges from 0 to about 900 ft in thickness. Recharge to the Memphis aquifer is from precipitation on the outcrop or by downward infiltration of water from the overlying fluvial deposits of Tertiary and Quaternary age and alluvium of Quaternary age. Long-term data indicate that water levels in the Memphis aquifer have declined at average rates ranging from less than 0.1 to 1.3 ft/yr during the period 1928-83. The water generally is a calcium bicarbonate type. It contains low concentrations of most major constituents and generally is suitable for most uses. Dissolved solids concentrations range from 19 to 333 mg/L. Seventy-six aquifer tests made during the period 1949-62 indicate that transmissivities range from 2,700 to 53,500 sq ft/day and storage coefficients range from 0.0001 to 0.003. The Memphis aquifer presently provides moderate to large quantities of water for many public and industrial water supplies in western Tennessee, and small quantities to numerous domestic and farm wells. Withdrawals for public and industrial supplies in 1983 averaged about 225 million gal/day, of which 183 million gal/day was in the Memphis area. The Memphis aquifer has much potential for future use, particularly outside the Memphis area. (USGS) W91-01851

#### HYDROLOGY OF THE POWDER RIVER ALLUVIUM BETWEEN SUSSEX, WYOMING, AND MOORHEAD, MONTANA.

Geological Survey, Cheyenne, WY. Water Resources Div.

## Water In Soils—Group 2G

B. H. Ringen, and P. W. Daddow.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4002, 1990. 48p, 17 fig, 7 tab, 20 ref. USGS Project No. WY078.

Descriptors: \*Alluvial aquifers, \*Montana, \*Potential water supply, \*Powder River Basin, \*Surface-groundwater relations, \*Wyoming, Dissolved solids, Moorhead, Sussex, Well data.

The potential for developing water supplies from the alluvium along the Powder River between Sussex, Wyoming, and Moorhead, Montana, is very limited. The areal extent and saturated thickness of the alluvium are not large. Water in the alluvium primarily is derived from seepage from the river, which goes dry periodically. Low flow is sustained by groundwater discharge or irrigation return flow near Sussex, but not near Arvada, Wyoming, or Moorhead. The alluvium and the river have good hydraulic connection, but evidently are isolated from the bedrock. Pumpage from wells completed in the alluvium is highly dependent on water supplied directly from the river. The quality of water in the alluvium also limits use of the water. Although the quality improves downstream, it is unacceptable for drinking water and possibly for irrigation and some industrial uses, but is acceptable for most livestock watering. (USGS) W91-01852

#### GEOHYDROLOGIC CHARACTERISTICS AND SIMULATED RESPONSE TO PUMPING STRESSES IN THE SPARTA AQUIFER IN EAST-CENTRAL ARKANSAS.

Geological Survey, Little Rock, AR. Water Resources Div.  
D. J. Fitzpatrick, J. M. Kilpatrick, and H. McWreath.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4201, 1990. 50p, 27 fig, 51 ref.

Descriptors: \*Arkansas, \*Geohydrology, \*Groundwater, \*Groundwater movement, \*Water studies, \*Sparta Aquifer, Water level fluctuations.

A finite difference digital model of the Sparta aquifer system in Arkansas was developed to aid in assessing the geohydrologic characteristics of the aquifer as well as the impact of withdrawals on water-level declines in the aquifer. The model consists of two layers. The Cockfield aquifer, represented by layer 1, was modeled as a constant head surface. The Sparta aquifer is represented by layer 2. The base of the Sparta aquifer was modeled as a no-flow boundary. The model boundaries to the north, south, and east in Mississippi were represented by specified heads, while boundaries to the west in Louisiana were represented as no flow. The model period of 1989 to 1985 was divided into 25 stress periods. Appropriate aquifer withdrawals were assigned to each stress period. Calibrated hydraulic conductivities of the Sparta aquifer, ranged from 1 to 35 ft/day. Calibrated hydraulic vertical conductivities of the Cook Mountain confining unit ranged from 0.0003 to 0.00009 ft/day. The calibrated storage coefficient of the aquifer was 0.0001. More than 80% of the recharge to the aquifer came from vertical leakage and from direct recharge on the outcrop. Greater than 90% of outflow from the aquifer was from pumpage or leakage to rivers. Theoretical pumping schemes to the year 2005 indicated that virtually no change to the potentiometric surface occurred when 1985 pumping rates were extended to 2005. Doubling of pumpage over the entire study area resulted in additional water-level declines of up to 130 ft. (USGS) W91-01854

#### GROUND-WATER LEVELS, FLOW, AND SPECIFIC CONDUCTANCE IN UNCONSOLIDATED AQUIFERS NEAR LAKE ERIE, CLEVELAND TO CONNEAUT, OHIO, SEPTEMBER 1984.

Geological Survey, Columbus, OH. Water Resources Div.

A. W. Coen.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4202, 1990. 22p, 7 fig, 9 ref.

Descriptors: \*Data collections, \*Groundwater, \*Hydrologic data, \*Ohio, \*Water resources data, Glacial drift, Specific conductivity, Water level, Water quality.

Groundwater levels and flow and specific conductance of water in aquifers underlying the southern shore of Lake Erie from Cleveland to Conneaut, Ohio were collected in September 1984 as part of the U.S. Geological Survey's Northeast Glacial Buried Valley Regional Aquifer-Systems Analysis. The 60 mile long study area extends inland from the lake about 10 miles and encompasses parts of Cuyahoga, Lake, and Ashtabula Counties. Water levels were measured in 202 wells, all of which were completed in glacial deposits. Specific conductance was measured in 59 of the wells. Water levels in most of the area are within 20 ft of the land surface. Groundwater flows locally toward streams and, regionally, to the north-northwest towards Lake Erie. Specific-conductance values ranged from 160 to 2,900 microsiemens/cm at 25 °C with a median value of 540 microsiemens/cm. Elevated specific-conductance values were randomly distributed areally and could derive from road-deicing salt, leachate from landfills, natural brines associated with oil and gas drilling, and the upward leakage of saline water from bedrock. (USGS) W91-01855

#### WATER RESOURCES DATA FOR IOWA, WATER YEAR 1989.

Geological Survey, Iowa City, IA. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01856

#### WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1988.

Geological Survey, Charleston, WV. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01858

#### WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1989.

Geological Survey, Lansing, MI. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01864

#### GROUND-WATER LEVELS, SPRINGS 1985, AND GROUND-WATER LEVEL CHANGES, SPRING 1983 TO SPRING 1985, IN THREE BASALT UNITS UNDERLYING THE COLUMBIA PLATEAU, WASHINGTON AND OREGON.

Geological Survey, Tacoma, WA. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01868

#### SPECIFIC CHEMICAL COMPOSITION OF KARST GROUNDWATER IN THE OPHIOLITE BELT OF THE YUGOSLAV INNER DINARIDES: A CASE FOR COVERED KARST.

Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.  
N. Kresic, and P. Papić.  
Environmental Geology and Water Sciences EGWSEI, Vol. 15, No. 2, p 131-135, March/April 1990. 7 fig, 8 ref.

Descriptors: \*Aquifer systems, \*Chemical analysis, \*Geochemistry, \*Geohydrology, \*Groundwater chemistry, \*Karst, \*Karst hydrology, \*Water chemistry, \*Yugoslavia, Limestone, Sedimentary rocks.

The Ophiolite Belt of the Yugoslav Inner Dinarides was considered to be a chaotic mélange of the

olistostrome type because of its very complicated tectonic fabric. Its sections of Triassic limestone were understood as thin slide sheets over ophiolites (diabases, cherts, ultramafics). Hydrogeological research, conducted in the last few years, refuted such theories. The results showed that Triassic limestone was much more common and was covered with ophiolites of the Jurassic age. Hydrochemical analysis established relationships between the main chemical components and groundwater in the area. They also made possible conclusions about the origin of karst groundwaters, properties of karst aquifers, and influences of ultramafics on the aquifers. Fifty-one percent of samples collected had characteristics of real calcareous waters. Thirty-three percent of the samples indicated a significant recharge of karst aquifers by leakage from ophiolite rocks. The remaining samples were waters with a calcium-magnesium ratio of less than one, which showed recharge from the ophiolites. By including silica content with the calcium-magnesium ratio, it became clear that magnesium in karst groundwater was from rocks rich in both magnesium and silica origin. Functional dependence between these elements has been proven. (Stoehr-PTT) W91-01885

## 2G. Water In Soils

#### TEMPORAL SOLUBILITY TRENDS OF ALUMINUM AND IRON LEACHED FROM COAL SPOILS AND CONTAMINATED SOIL MATERIALS.

Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.  
For primary bibliographic entry see Field 5B.  
W91-01007

#### LEACHING OF RADIONUCLIDES FROM DECAYING BLUEBERRY LEAVES: RELATIVE RATE INDEPENDENT OF CONCENTRATION.

Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.  
For primary bibliographic entry see Field 5B.  
W91-01018

#### ATRAZINE AND BROMIDE MOVEMENT THROUGH A SILT LOAM SOIL.

Agricultural Research Service, Beltsville, MD. Environmental Chemistry Lab.  
For primary bibliographic entry see Field 5B.  
W91-01022

#### SORPTION OF NAPROPAMIDE ON CLAY AND SOIL IN THE PRESENCE OF DISSOLVED ORGANIC MATTER.

National Taiwan Univ., Taipei. Dept. of Agricultural Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-01023

#### SOME PHYSICAL PROPERTIES OF STRUCTURAL AGGREGATES SEPARATED FROM ORGANIC WASTE-AMENDED SOILS.

Nigeria Univ., Nsukka. Dept. of Soil Science.  
For primary bibliographic entry see Field 5E.  
W91-01054

#### VARIABILITY AND DYNAMICS OF LEACHING OF THE FLYSCH CARPATHIAN SLOPE.

Polish Academy of Sciences, Krakow. Inst. of Geography and Spatial Organization.  
A. Welc.  
Catena, Vol. 16, No. 2, p 425-435, April 1989. 9 ref, 2 tab, 13 ref.

Descriptors: \*Carpathian Mountains, \*Flysch, \*Geochemistry, \*Leaching, \*Water circulation, \*Weathering, Climates, Groundwater flow, Sandstones, Seasonal variation, Shales.

The mechanism, dynamics and variability of leaching caused by water circulation within the various flysch slopes in the Polish Carpathian Mountains was investigated using two slopes as examples.

## Field 2—WATER CYCLE

### Group 2G—Water In Soils

Leaching on the slopes built of Magura sandstones is less intensive than that on the slopes sculptured in limy sandstones and marly shales. In the case of the first slope, the salts were carried away mainly by groundwater circulating in deeper levels of the weathering covers and rocky substratum. In the second case, the majority of the salts were carried away by surface and shallow subsurface runoff. Therefore, lithological differentiation of the flysch affected the water circulation pattern and leaching of the slopes. Differentiated climatological conditions during one year resulted in patterns and intensities characteristic for a given condition of leaching of the slopes. Irregular influences of the oceanic and continental climates in this part of Europe cause the leaching to prevail in summer in certain years and in winter in others. Studies lasting several years indicated that leaching of slopes prevailed in the winter period with particular intensification of the process in January and March. Despite the long-lasting periods of leaching of the slope covers in some years, short periods usually decide the magnitude of leaching. (Author's abstract)

W91-01078

#### HUMUS FORM DEVELOPMENT AND HILLSLOPE RUNOFF, AND THE EFFECT OF FIRE AND MANAGEMENT, UNDER MEDITERRANEAN FOREST IN NE-SPAIN.

Amsterdam Univ. (Netherlands). Lab. for Physical Geography and Soil Science.  
J. Sevinck, A. C. Ineson, and J. M. Verstraten.  
Catena, Vol. 16, No. 2, p 461-475, April 1989. 3 fig, 4 tab, 16 ref.

Descriptors: \*Decomposing organic matter, \*Forest fires, \*Forest management, \*Forest soils, \*Humus, \*Runoff, \*Soil types, \*Spain, \*Wetlands, Infiltration capacity, Plant growth, Soil horizons, Soil water.

Study of a series of plots on acid to intermediate rocks under well preserved mediterranean type forests in northeast Spain showed that soils have well developed mor or moder type humus forms. Mor type humus forms were observed in soils with a shallow lithic contact or an abrupt textural change, and consist of an ectorganic layer (L, Fg, H) abruptly overlying a generally water repellent Ae or E horizon. Moder type humus forms, with a gradual transition between ectorganic layer (L, Fa and Ah horizon), were found in soils with more favorable rooting and soil moisture conditions, indicating that these conditions have a strong control over humus development. Quantities of organic matter (ectorganic layer and Ah/Ae) ranged from about 5 kg/sq m in mor to about 10 kg/sp m in moder humus forms, the difference being due to the presence of a well-developed Ah horizon in the latter. Rainfall simulator experiments showed that slopes with more type humus forms are likely to produce hillslopes runoff during summer rain storms in spite of the relatively high storage capacity of the ectorganic layer. This is due to the hydrophobicity of the mineral top soil (if dry), which hampers infiltration. Furthermore, during the wet season the soils commonly have a perched water table, inducing saturated overland flow. Slopes with moder type humus forms, on the contrary, are very unlikely to produce any hillslope runoff, because of the high storage and infiltration capacity of the soils. (Author's abstract)

W91-01079

#### IDENTIFICATION, CHARACTERIZATION, AND HYDROLOGICAL IMPLICATIONS OF WATER REPELLENCY IN MOUNTAIN SOILS, SOUTHERN BRITISH COLUMBIA.

Toronto Univ. (Ontario). Dept. of Geography.  
G. Barrett, and O. Slaymaker.  
Catena, Vol. 16, No. 2, p 477-489, April 1989. 8 fig, 1 tab, 23 ref.

Descriptors: \*British Columbia, \*Soil moisture retention, \*Soil water, \*Water repellent soils, Organic matter, Soil chemistry, Soil physical properties, Soil profiles.

The physicochemical properties of soils, which determine how readily the soils wet, were shown

to vary significantly in mountain soils collected at six sites in southern British Columbia, even within individual profiles. The results of water drop penetration time were used to classify samples using a very simple scheme which is based upon the current understanding of the possible physicochemical interactions between soil surfaces, water, and soil air. In all cases where the samples were collected at sites in the subalpine-alpine ecotone, a layer which either wets reluctantly or is water-repellant exists at or near the surface of the profile. These layers occur only where there is evidence for accumulation of organic matter, and are usually no more than a few centimeters thick. At the one site which was below the alpine-subalpine ecotone, the soils wet readily throughout the profile. These results suggest that the type of organic matter which accumulates in soils of the alpine-subalpine ecotone of southern British Columbia either limits the affinity of soils for water or renders the soil water-repellant. (Author's abstract)

W91-01080

#### APPLICATION OF A SIMPLE LUMPED RIVER FLOW FORECASTING MODEL TO HILLSLOPE SOIL WATER STORAGE ESTIMATION.

Kobe Univ. (Japan). Dept. of Agricultural Engineering.  
T. Hata, and M. G. Anderson.  
Catena, Vol. 17, No. 3, p 249-259, June 1990. 5 fig, 1 tab, 21 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*River flow, \*River forecasting, \*Soil water, Catchments, Hydrology, Slopes, Topography, Watersheds.

For a number of applied geomorphological and hydrological problems, the prediction of hillslope soil water conditions from restricted data is frequently required. Physically based distributed models of catchment hydrology are currently regarded as too cumbersome to meet these requirements either operationally or in a standard research context. A simple lumped sequential flow forecasting model is applied to a 0.73 sq km catchment. The catchment selected for modeling was located at Winford, near Bristol, England. Parameterization of the model was undertaken using the following data sources: 193 days of daily precipitation, air temperature, soil moisture, and discharge data. The hillslope sectors, into which the catchment is subdivided, are represented by their mean slope angles and are assumed rectangular in plan. Each hillslope sector has its own maximum water storage. The governing equations of subsurface, overland, and channel flow utilize Darcy's equation, Manning's equation, and the continuity equation. If field permeability is available, there is significant potential for the scheme to estimate the mean soil water storage in catchment segments. In addition, the model provides reliable river flow forecasting. Further, more extensive trials of the model are needed on catchments with differing topography to compare with the preliminary results reported here. (Author's abstract)

W91-01086

#### RAINFALL INDUCED SOIL SEAL (C) A DYNAMIC MODEL WITH KINETIC ENERGY INSTEAD OF CUMULATIVE RAINFALL AS INDEPENDENT VARIABLE.

Hebrew Univ., Rehovoth (Israel). Dept. of Soil and Water Sciences.  
Y. Muallem, S. Assouline, and H. Rohdenburg.  
Catena, Vol. 17, No. 3, p 289-303, June 1990. 7 fig, 2 tab, 27 ref, append.

Descriptors: \*Hydrologic models, \*Kinetic energy, \*Rainfall, \*Soil compaction, \*Surface sealing, \*Water repellent soils, Infiltration capacity, Rainfall infiltration, Rainfall intensity, Soil sealants, Soil types.

A dynamic model of soil sealing, based on an extension of a previous model that considers the seal as a non-uniform layer, and the rainfall kinetic energy as the rain property dominating the sealing process is presented. The model was applied in the case of two soils, sandy loam and loam, under

saturated conditions, using an inverse procedure for its calibration. The validity of the theoretical model was examined for each soil by results of an infiltration test carried out under rainfall and flow boundary conditions different from those related to the data used for the model calibration. Very good agreement was found between the observed and the predicted infiltration curves in the case of sandy loam, but not as good in the case of loam soil. The error that may occur when using cumulative rainfall instead of rainfall kinetic energy as the independent variable of the soil sealing model was analyzed under varying conditions. In cases where the rainfall kinetic energy per unit mass is a constant, independent of the rainfall intensity, the use of the cumulative rainfall is equivalent to the use of the rainfall kinetic energy. However, rainfall events often include long rainfall of low intensity and short time intervals of high rainfall intensity, with the kinetic energy per unit mass varying considerably during a single rainfall event. In such a case, the use of the cumulative rainfall as the model variable may lead to considerable error. Applying the calibrated model for the sandy loam and characteristics of simulated and natural rainfall, the error associated with the use of the cumulative rainfall was found to lead to a large error in calculation of the infiltration rate during the sealing process. (Author's abstract)

W91-01089

#### TEMPORAL VARIABILITY OF SOIL WETNESS AND ITS IMPACT ON CLIMATE.

Princeton Univ., NJ. Geophysical Fluid Dynamics Program.

S. Manabe, and T. Delworth.

Climatic Change CLCHDX, Vol. 16, No. 2, p 185-192, April 1990. 3 fig, 1 tab, 9 ref.

Descriptors: \*Climates, \*Climatology, \*Clouds, \*Mathematical models, \*Soil water, Carbon dioxide, Diurnal variation, Evaporation, Precipitation, Relative humidity, Seasonal variation, Temporal distribution, Variability.

The temporal variability of soil wetness and its interactions with the atmosphere were studied using a general circulation model of the atmosphere, in which zonally uniform clouds are prescribed as a function of latitude and height; carbon dioxide is constant everywhere; the diurnal cycle is omitted but the seasonal cycle is included; the geographical and seasonal distribution of sea surface temperature and sea ice are prescribed; and precipitation is predicted whenever the relative humidity exceeds 100%. Time series of soil wetness computed by the model contain substantial amounts of variance at low frequencies, suggesting that interactions between soil moisture and the atmosphere have the potential to make substantial contributions to low frequency atmospheric variability. Long time-scale anomalies of soil moisture resemble the red noise response of the soil layer to white noise rainfall forcing. The temporal variability of soil moisture depends upon potential climatic values of evaporation and precipitation. (Brunone-PTT)

W91-01090

#### HYDROLYSIS OF CHLOROSTILBENE OXIDE: II. MODELING OF HYDROLYSIS IN AQUIFER SAMPLES AND IN SEDIMENT-WATER SYSTEMS.

Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.  
For primary bibliographic entry see Field 5B.

W91-01256

#### RELATION BETWEEN SATURATED CONDUCTIVITY AND CAPILLARY RETENTION CHARACTERISTICS.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.

For primary bibliographic entry see Field 2F.

W91-01303

## Water in Soils—Group 2G

**EFFECT OF ROCK BUNDS AND TIED RIDGES ON SOIL WATER CONTENT AND SOIL PROPERTIES IN THE SUDAN SAVANNAH OF BURKINA FASO.**

Semi-Arid Food Grain Research and Development Office, Ouagadougou (Burkina Faso).  
For primary bibliographic entry see Field 3F.  
W91-01330

**ZINC IN POOR SANDY SOILS AND ASSOCIATED GROUNDWATER. A CASE STUDY.**

Amsterdam Univ. (Netherlands). Landscape and Environmental Research Group.  
For primary bibliographic entry see Field 5B.  
W91-01450

**BASIC MODEL OF WATER- AND GAS-FLOW THROUGH SMECTITE CLAY BUFFERS.**

Clay Technology A.B., Lund (Sweden). Ideon Research Center.  
R. Pusch, and H. Hokmark.  
Engineering Geology EGGOAO, Vol. 28, No. 3/4, p 379-389, 1990. 9 fig, 8 tab, 6 ref.

Descriptors: \*Bentonite, \*Clay minerals, \*Clays, \*Hazardous waste disposal, \*Liners, \*Radioactive waste disposal, \*Smectite, \*Soil physical properties, \*Soil porosity, \*Void space, Gels, Geohydrology, Hydration, Hydraulic properties, Interstitial water, Montmorillonite, Permeability, Sodium, Soil density, Soil water, Sweden.

A large number of voids combine to form natural passageways for water or gas in soft rather than in very dense smectite clays. The very dense artificially-produced sodium (Na) montmorillonite clay materials used for isolating purposes in Swedish repositories for radioactive wastes have microstructural features formed by the initial arrangement of bentonite grains that are compressed to yield elements of highly compacted bentonite. Canister embedment of highly compacted Na bentonite forms a low-permeable medium of significant homogeneity both macroscopically and microscopically. However, despite the fact that a large part of the pore water is in interlamellar positions and not mobile by ordinary hydraulic gradients, there are still a number of pore passages that let water and gas through even at very high bulk densities. A microstructural model of artificial Na montmorillonite clay was examined. A study of this model indicates that the microstructure of 'artificial' Na montmorillonite clay, formed from bentonite powder grains, controls all the relevant transport mechanisms. The key feature of the model is that the dense grains constitute a basic network with continuous 'external' voids of varying size. At hydration of the system under confined conditions the grains expand and reduce the porosity, and the remaining voids become filled by soft clay gels that emanate from the dense grains. The density of these gels is a function of the void size; there is a significant variation in hydraulic and gas conductivities as well as in ion diffusivity over a cross-section of the clay. (Fish-PTT)  
W91-01458

**DUAL WATER FLOW PATTERN IN THE UNSATURATED ZONE UNDER A GYPSUM-AMENDED SOIL.**

Weizmann Inst. of Science, Rehovot (Israel).  
H. Gvirtzman, M. Magaritz, and A. Nadler.  
Journal of Soil Science JSSCAH, Vol. 41, No. 2, p 177-187, June 1990. 7 fig, 1 tab, 20 ref.

Descriptors: \*Aeration zone, \*Flow velocity, \*Gypsum, \*Infiltration, \*Soil amendments, \*Soil science, \*Soil water, \*Solute transport, Boreholes, Environmental tracers, Field tests, Groundwater movement, Irrigation water, Loess, Saline groundwater, Tritium.

Substantial progress has been made in describing the process of water and solute transport in the unsaturated zone by means of mathematical and conceptual models, and by column displacement experiments. Unfortunately, field studies, which are of critical importance for understanding natural transport processes in the unsaturated zone, are still relatively rare, possibly due to the methodo-

logical difficulties of tracing water and solute transport. One of the methods for conducting in situ field measurements is by using environmental isotopes as tracers, such as tritium. The tritium dating method was applied in order to describe the water flow mechanism in a natural field that has been irrigated by saline sodic waters and reclaimed by extensive gypsum application. Sediment samples were obtained from boreholes down to approximately 20 m in a gypsum-treated, saline water irrigated soil, and from nearby uncultivated fields at two locations. Measurements of tritium concentrations in the soil solution enabled the determination of two types of flow in the unsaturated zone: fast and slow. The slow component, the 'piston-flow type' in the sandy loess section of the first location had a vertical velocity of 0.16m/a, and in the clayey loess section of the second location had a vertical velocity of 0.23 m/a. The faster component typically transported the solution through fractures and other preferred paths. The percentage of the slow component was 40% in the sandy and 60% in the clayey loess. A previous prediction of delayed transport of salts was verified and is related to the interaction between chemical composition of irrigation water and the agrotechnical practices of gypsum application. (Fish-PTT)  
W91-01475

**SIMPLIFIED ANALYSIS OF SOIL WATER FLOW TO A MOLE DRAIN.**

Massey Univ., Palmerston North (New Zealand). Dept. of Soil Science.  
D. R. Scotter, L. K. Heng, D. J. Horne, and R. E. White.  
Journal of Soil Science JSSCAH, Vol. 41, No. 2, p 189-198, June 1990. 4 fig, 1 tab, 21 ref.

Descriptors: \*Data interpretation, \*Mole drainage, \*Soil water, \*Soil water table, \*Surface runoff, \*Surface-groundwater relations, Drainage coefficient, Drainage practices, Dupuit-Forchheimer theory, Evaporation, Flow rates, Hydraulic conductivity, Hydrographs, Percolation, Rainfall intensity, Soil porosity, Soil properties, Soil science, Soil texture.

There is a long standing interest in simplified analyses of soil water movement to drains as a function of rainfall and soil hydraulic properties. An analysis has been developed which allows transient mole drain flow, surface runoff and water table depth to be computed, given measured or assumed values for rainfall, evaporation, deep percolation, mole drain spacing and depth, surface detention, the drainage coefficient, and the saturated hydraulic conductivity, total porosity and macroporosity of the topsoil and subsoil. The Dupuit-Forchheimer flow below the water table, and the vertical hydraulic potential equilibrium above the water table are assumed. The analysis was successfully tested by simulating the hydrographs for three contrasting rainfall events in New Zealand in 1988. The 6 October rainfall event was short and intense. The 29 June event had a lower maximum intensity and extended over a longer period. The 24 July rainfall event was unusually large and intense. Of note are the high maximum drain flow rates, and the rapid response of the drainage flow to changes in rainfall intensity. Only during this large rainfall event did a quasi-steady state occur, with drain flow approximately equal to rainfall intensity. The peak flow rates indicate how effective preferential flow can be in moving water to mole drains in fine-textured soils. The prediction of somewhat earlier than observed initial responses in drain flow to rain is probably due to the assumption of instantaneous vertical hydraulic potential equilibrium in the soil. This approach for modeling the behavior of mole drains is easy to use, and needs only readily obtainable soil physical and weather data as inputs. (Fish-PTT)  
W91-01476

**CALIBRATION AND VALIDATION OF A MODEL OF NON-INTERACTIVE SOLUTE LEACHING IN A CLAY-LOAM ARABLE SOIL.**

Edinburgh School of Agriculture (Scotland). Dept. of Soil Science.  
For primary bibliographic entry see Field 7C.  
W91-01477

**RELEASE OF CATIONIC ALUMINIUM FROM ACIDIC SOILS INTO DRAINAGE WATER AND RELATIONSHIPS WITH LAND USE.**

University Coll. of Wales, Aberystwyth. Soil Science Unit.  
For primary bibliographic entry see Field 5B.  
W91-01479

**SOIL AND SOIL SOLUTION CHEMICAL COMPOSITION AT THREE SITES WITHIN THE LOCH DEE CATCHMENT, SW SCOTLAND.**

Stirling Univ. (Scotland). Dept. of Environmental Science.  
For primary bibliographic entry see Field 2K.  
W91-01480

**EXPERIMENTAL TESTING OF TRANSIENT UNSATURATED FLOW THEORY AT LOW WATER CONTENT IN A CENTRIFUGAL FIELD.**

Geological Survey, Menlo Park, CA. Water Resources Div.  
J. R. Nimmo.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 1951-1960, September 1990. 10 fig, 1 tab, 26 ref.

Descriptors: \*Flow equations, \*Hydraulic conductivity, \*Laboratory methods, \*Soil properties, \*Soil water, \*Unsaturated flow, Centrifugation, Experimental data, Sand, Testing procedures.

Experimental measurements and theoretical predictions of transient moisture conditions have been compared for a sandy soil approaching hydrostatic equilibrium in a centrifugal field. Starting near saturation, samples were centrifuged at constant speed with a constant suction at the outflow boundary. Water flowed freely out of the sample through a porous plate. Step increases in centrifuge speed produced transient moisture conditions suitable for comparison between experiment and theory. Measurements of electrical conductivity by a direct contact four-electrode technique indicated the water content according to a calibration based on known moisture conditions at various equilibrium states. A specially modified centrifuge permitted electrical measurements during centrifugation. For comparison, the transient water contents were computed by a finite-difference solution of Richards' equation (modified by replacing gravitational with centrifugal potential), using soil characteristics measured previously by steady state techniques. The time dependence of water content changes, used as the basis for comparison between experiment and theory, shows agreement which is reasonable given the degree of uncertainty of the measurements. The experiment confirms, within a factor of 4, the validity of Richards' equation for moisture conditions as dry as 25% of saturation, over a hydraulic conductivity range of  $5 \times 10^{-10}$  to the minus 11th power to  $1 \times 10^{-10}$  to the minus 8th power m/s, and in a centrifugal field up to about 200 g. (Author's abstract)  
W91-01514

**INVERSE SOLUTION FOR ONE-DIMENSIONAL INFILTRATION, AND THE RATIO A/K<sub>1</sub>.**

Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.  
J. R. Philip.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2023-2027, September 1990. 1 fig, 2 tab, 10 ref.

Descriptors: \*Infiltration, \*Mathematical analysis, \*Soil water, \*Unsaturated flow, Infiltration coefficient, Mathematical equations, Soil physical properties, Soil texture.

The inverse method of solving the nonlinear diffusion equation was extended to give the two leading terms of the infiltration series solution of the nonlinear Fokker-Planck equation of unsaturated flow. The method was used, together with a new integral result for the ratio  $A/K_1$ , to investigate the physical determinants of  $A/K_1$ .  $K_1$  is the saturated

## Field 2—WATER CYCLE

### Group 2G—Water In Soils

conductivity, and A the second coefficient of the two-term infiltration equation  $i = S(1/2) + At$ . The relatively superficial direct effect of the initial moisture content  $\theta_0$  (important only when  $\theta_0$  is very large) was separated from the more complicated effect, dependent both on soil texture and on  $\theta_0$ , of the shapes of the diffusivity D and the conductivity derivative  $dK/d\theta$ . Normalized first moments of these functions measure the steepness of their variation. The full range of combinations of shapes of D and  $dK/d\theta$  from essentially flat to essentially infinite steep was examined. For soils with  $K_0/k_1$  negligibly small,  $A/K_1$  lies in the range 0 to 2/3. The dominant physical effect is that  $A/K_1$  decreases monotonically as  $dK/d\theta$  increases in steepness. On the other hand,  $A/K_1$  increases (relatively slowly) with the steepness of D. (Author's abstract)  
W91-01519

#### APPROXIMATE SOLUTIONS FOR CATION TRANSPORT DURING UNSTEADY, UNSATURATED SOIL WATER FLOW.

Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils. W. J. Bond, and I. R. Phillips.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2195-2205, September 1990. 6 fig, 42 ref, 2 append. Australian Water Research Advisory Council Project 84/164.

Descriptors: \*Mathematical analysis, \*Path of pollutants, \*Porous media, \*Soil water, \*Solute transport, \*Unsteady flow, \*Unsteady flow, Adsorption, Cation exchange, Cations, Dispersion, Infiltration, Interstitial water, Isotherms.

Approximate analytical solutions were derived for the transport of reactive solutes during unsteady flow of water in unsaturated porous media. The solutions apply to solutes that undergo adsorption reactions including ion exchange, specific adsorption, or negative adsorption (anion exclusion). No particular form of adsorption or exchange equation was assumed, and solutions were developed for both unfavorable (concave upward) and favorable (convex upward) isotherms, as well as for multisite isotherms. The main approximations that were assumed in deriving the solutions are (1) that local chemical and physical equilibrium is attained rapidly relative to the time scale for transport, (2) that the reaction takes place in a region of constant total charge concentration in both the solution and solid phases, (3) that the effects of dispersion and the shape of the adsorption isotherm may be treated separately and then combined, and (4) that as has been assumed previously for unsteady flow of nonreactive solutes, the water content and pore water velocity may be treated as constant over the region of dispersion. The solutions were tested using experimental data for the transport of exchanging cations during horizontal infiltration in laboratory columns. The solution for unfavorable isotherms was compared with data for sodium invading a calcium-dominated soil; that for multisite isotherms, which combines the solutions for both favorable and unfavorable isotherms, was compared with data for potassium invading a calcium-dominated soil. In both cases, good agreement was found between the measured distributions of solution and sorbed cations and those predicted using these solutions together with independently measured cation exchange isotherms. (Author's abstract)  
W91-01535

#### STOCHASTIC ANALYSIS OF UNSATURATED FLOW: ONE-DIMENSIONAL MONTE CARLO SIMULATIONS AND COMPARISONS WITH SPECTRAL PERTURBATION ANALYSIS AND FIELD OBSERVATIONS.

California Univ., Davis. Dept. of Land, Air and Water Resources.  
K. Unlu, D. R. Nielsen, and J. W. Biggar.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2207-2218, September 1990. 13 fig, 2 tab, 21 ref.

Descriptors: \*Hydraulic properties, \*Model studies, \*Monte Carlo method, \*Soil water, \*Stochastic models, \*Unsteady flow, Flow equations,

Hydraulic conductivity, Mathematical models, Statistical analysis.

A numerical experiment was designed to study the stochastic behavior of one-dimensional transient unsaturated flow in a Monte Carlo setting. Soil hydraulic properties, log-saturated hydraulic conductivity ( $\ln K$  sub s), pore size distribution parameter ( $\alpha$ ), and the specific water capacity (C) were assumed to be statistically homogeneous random fields described by exponential correlation functions with identical correlation lengths. Fifty realizations of each soil hydraulic property, with statistical properties obtained from a field experiment, were generated by using a nearest-neighbor model. Numerical solutions of the one-dimensional flow equation are used repeatedly to obtain realizations of soil water pressure head and flux corresponding to the realizations of  $\ln K$  sub s,  $\alpha$ , and C. The dependence of the pressure head and flux on the statistical properties of  $\ln K$  sub s,  $\alpha$ , and C and the magnitude of the hydraulic head gradient prevailing at the lower boundary were investigated. In addition, results of Monte Carlo analysis and spectral perturbation analyses were compared with field observations. The greatest variability of the soil water pressure head and flux were observed when soil hydraulic properties are uncorrelated and have large variances and integral scales and when G at the lower boundary is unity. The Monte Carlo and spectral perturbation analyses tend to agree reasonably well for the flow domains in which ergodicity of local soil hydraulic properties is assured. Results of the Monte Carlo and spectral perturbation analyses are also supported by field observations. (Author's abstract)  
W91-01536

#### SOIL SOLUTION CHEMISTRY OF AN ADIRONDACK SPODOSOL: LYSIMETRY AND N DYNAMICS.

State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry.  
For primary bibliographic entry see Field 2K.  
W91-01693

#### STANDING-WATER DEPOSITS AS INDICATORS OF LATE QUATERNARY DUNE MIGRATION IN THE NORTHWESTERN NEGEV, ISRAEL.

Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Isotope Research.  
For primary bibliographic entry see Field 2J.  
W91-01695

#### CROPPING SYSTEM AND TILLAGE EFFECTS ON AVAILABLE SOIL WATER AND YIELD OF GRAIN SORGHUM AND WINTER WHEAT.

Southwest Kansas Research-Extension Center, Garden City.  
For primary bibliographic entry see Field 3F.  
W91-01705

#### CLIPPING DATE EFFECTS ON SOIL WATER AND REGROWTH IN CRESTED WHEAT-GRASS.

Oregon State Univ., Union. Eastern Oregon Agricultural Research Center.  
R. F. Miller, M. R. Haferkamp, and R. F. Angell.  
Journal of Range Management JRMGAQ, Vol. 43, No. 3, p 253-257, May 1990. 2 fig, 6 tab, 23 ref.

Descriptors: \*Agricultural practices, \*Soil water, \*Soil-plant-water relationships, \*Wheat, Defoliation, Forages, Water potentials.

Although extensive work has evaluated plant response to season of defoliation, few studies have evaluated the influence of season of defoliation on soil water depletion, amount of regrowth, and total seasonal biomass production. This 5-year study evaluated the effect of clipping date and yearly climatic variation on soil water depletion, amount of regrowth, and total seasonal forage production. Timing of clipping significantly affected soil water depletion patterns. Clipping at the early vegetative phase had little effect on soil water potential unless soil water potentials were below 0.03 MPa. In mid-June soils beneath plants defoliated during the boot

stage were consistently wetter than soils beneath undefoliated plants. However, total seasonal soil water depletion was usually similar among treatments by the end of the growing season. Phenology and the amount of standing crop present when defoliation occurred were significantly correlated with regrowth. Date of defoliation also significantly affected total production in wet years. Total seasonal foliage production on plots clipped during the boot stage was generally lower than on plots clipped during the vegetative or late flowering stages of development. (Author's abstract)  
W91-01706

#### EFFECT OF SOIL WATER, NITROGEN, AND GROWING DEGREE-DAYS ON MORPHOLOGICAL DEVELOPMENT OF CRESTED AND WESTERN WHEAT-GRASS.

Agricultural Research Service, Mandan, ND. Northern Great Plains Research Center.  
For primary bibliographic entry see Field 2I.  
W91-01707

#### CAUSES OF SOIL SALINIZATION: 2. A BASIN IN EAST-CENTRAL ALBERTA, CANADA.

Alberta Agriculture, Lethbridge.  
M. J. Hendry, G. W. Chan, and D. B. Harker.  
Ground Water GRWAAP, Vol. 28, No. 4, p 544-550, July/August 1990. 8 fig, 2 tab, 13 ref.

Descriptors: \*Alberta, \*Evaporation, \*Geohydrology, \*Groundwater, \*Groundwater flow, \*Model studies, \*Saline soils, \*Tritium, Canada, Flow models, Hydraulic conductivity, Ponding, Snow-melt, Water table.

The cause of soil salinization in a 21-ha area of gently rolling topography in Alberta was investigated. The geology of the basin consists of lenticular Cretaceous sediments overlain by tills and lacustrine deposits. Interpretation of vertical hydraulic-head data showed that regional discharge of groundwater from bedrock is not a cause of salinization in the study area. Results of stream function modeling suggested that most of the water causing salinization is not derived from local topographic highs. Modeling results also suggested that the direction of groundwater flow throughout the area is vertically downward through unconsolidated Quaternary deposits and into bedrock. Tritium analyses of pore water distilled from core samples confirmed that the groundwater causing salinization was not derived from the local topographic highs, nor from the deeper geologic deposits. Hydrograph analysis indicated that the salinization was derived from evaporation from seasonally high water tables caused by ponded surface water and spring snowmelt in localized depressional areas. (See also W90-09139) (Author's abstract)  
W91-01783

#### EVALUATE A SOIL LOSS PREDICTION MODEL COMBINED WITH AN INFILTRATION MODEL FOR TILLED SOILS.

South Dakota State Univ., Brookings. Dept. of Agricultural Engineering.  
S. T. Chu, and R. A. Kohl.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-217233/AS. Price codes: A03 in papercopy, A01 in microfiche. South Dakota Water Resources Institute, Brookings, Completion Report, August 1988. 23p, 1 fig, 12 tab, 7 ref. USGS Contract No. 14-08-0001-G1449-04. USGS Project No. G1449-04.

Descriptors: \*Infiltration models, \*Sediment erosion, \*Soil conservation, \*Soil erosion, \*Soil stabilization.

Soil and water are two basic resources necessary to human existence. Soil erosion strips the top soil away from the ground surface and depletes the productivity of the land. The transported sediment fills the reservoirs and accumulates in the waterways, which shortens the life of reservoirs and is the major cause of downstream flooding problems. Nutrients, organic matter, pesticides and insecticides carried by the sediments are the primary sources of water pollution from agricultural lands.

A soil loss prediction model is a useful tool to identify erosion hazard sites and is a time saving substitute for the field measurements. Soil loss estimation and prediction is an integral part of a well organized soil erosion control program. The purpose of this research was to combine an infiltration model for tilled soils with an existing soil loss model for soil loss prediction on tilled soils. Horton's model was shown to be adequate to describe the infiltration process on bare tilled soil where the development of a surface seal is the mechanism to determine surface runoff. The Green-Ampt infiltration model was shown to be adequate to describe the infiltration process on well protected tilled Vienna loam. For the partially protected tilled soil plots, neither of the two infiltration models provides good performance. The sediment loading ratio was shown to be a useful parameter in soil loss prediction. The product of the sediment loading ratio and the calculated runoff from the infiltration models is the predicted soil loss. (USGS) W91-01861

#### **SURFACE COVER EFFECTS ON SOIL INFILTRATION.**

South Dakota State Univ., Brookings. Dept. of Agricultural Engineering.  
R. A. Kohl, and S. T. Chu.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-217258/AS. Price codes: A02 in paper copy, A01 in microfiche. South Dakota Water Resources Institute Brookings, Completion Report, 1988. 4p, 1 tab, 3 ref. ASAE Paper No. 88-2004. USGS Contract No. 14-08-0001-G1252. USGS Project No. G1252-06.

Descriptors: \*Infiltration, \*Infiltrometers, Soil sealants, Surface sealing.

Permeable and impermeable pieces representing soil residue were placed on the soil and the plots were exposed to a sprinkling infiltrometer. Both surface cover treatments increased infiltration rates compared to bare soil. The soil under the central portion of the permeable cover had higher infiltration rates than under the impermeable cover. (USGS) W91-01863

#### **MODELLING SOIL WATER SUPPLY TO CROPS.**

Wye Coll., Ashford (England). Dept. of Agriculture, Horticulture and the Environment.  
H. F. Cook, and D. L. Dent.  
Catena, Vol. 17, No. 1, p 25-39, February 1990. 10 fig, 29 ref.

Descriptors: \*Agricultural hydrology, \*Agronomy, \*Model studies, \*Simulation analysis, \*Soil surveys, \*Soil water, \*Soil-water-plant relationships, Crop yield, Hydraulic conductivity, Soil moisture retention, Soil properties, Soil water potential, Transpiration, Water demand, Water supply.

Process simulation models are needed to make use of static soil survey data to predict crop performance. One critical link in this chain, the supply of water by the soil to meet the transpirational demand of crops, has been modelled on the assumption that water supply is directly related to soil water potential. Field testing of this simple model shows a close correlation between predicted and measured supply of water over a range of crops and soils grouped according to their soil water release characteristics. Crop water use and soil water-induced stress can be predicted by a demand-supply model based on: water demand estimated from Penman evapotranspiration and K sub c values for the crop; allocation of this demand through the soil profile according to the activity of the root system; water release by the soil according to soil water potential (the model requires soil water release curves for the topsoil and subsoil or classification of soils into hydrological families defined by their soil water release characteristics); and estimates of effective rainfall and upward flux of water from below the root zone. (Author's abstract) W91-01869

#### **RAINFALL INDUCED SOIL SEAL: (A) A CRITICAL REVIEW OF OBSERVATIONS AND MODELS.**

Hebrew Univ., Rehovoth (Israel). Dept. of Soil and Water Sciences.  
Y. Mualem, S. Assouline, and H. Rohdenburg.  
Catena, Vol. 17, No. 2, p 185-203, April 1990. 45 ref.

Descriptors: \*Infiltration, \*Infiltration rate, \*Model studies, \*Rainfall impact, \*Reviews, \*Runoff, \*Soil surfaces, \*Surface sealing, Chemical properties, Hydraulic conductivity, Particle size, Particulate matter, Physical properties, Soil properties, Soil water, Suspended solids.

Most soils exposed to rainfall are subjected to physical and chemical processes which change their properties at the vicinity of the soil surface. This phenomenon, called soil seal, can be harmful to agriculture. It decreases the infiltration rate, reduces the available water at the root zone, increases runoff and soil erosion and affects seedling and plant growth. This review explains the definition of rainfall induced soil seal, the mechanisms involved in its formation, its properties, and its role in shaping the soil water regime. The review concludes: (1) no universal seal, such as skin 0.1 mm, can accurately represent a real seal layer, (2) seal properties depend on both rainfall and soil properties, (3) soil sealing depends on initial and boundary conditions, (4) the infiltration rate is determined by the state and properties of the seal layer, as well as the undisturbed subsoil subjected to the particular boundary conditions; and (5) the physical identity of soil seal cannot be fully represented by visible parameters, even with the aid of microscopes or scanning electron microscopy. (See also W91-01873) (Stoehr-PTT) W91-01872

#### **RAINFALL INDUCED SOIL SEAL: (B) APPLICATION OF A NEW MODEL TO SATURATED SOILS.**

Hebrew Univ., Rehovoth (Israel). Dept. of Soil and Water Sciences.  
Y. Mualem, S. Assouline, and H. Rohdenburg.  
Catena, Vol. 17, No. 2, p 205-218, April 1990. 9 fig, 1 tab, 11 ref.

Descriptors: \*Hydraulic conductivity, \*Hydraulic gradient, \*Infiltration, \*Infiltration rate, \*Model studies, \*Rainfall impact, \*Saturated soils, \*Soil types, Clays, Loam, Physical properties, Sand, Silt, Soil properties, Soil water, Surface permeability, Suspended solids.

A conceptual model is proposed in which the saturated soil seal (crust) properties are derived on the basis of physical concepts estimated empirically. The reduced hydraulic conductivity of the soil surface is attributed to its decreased porosity and increased ineffective water content. The characteristics of the modeled soil seal were examined using data of sandy loam and loam (loess) soils. An inverse approach was applied for calibration using infiltration rate data. The results indicate that the importance of the 0.1 mm compact clay and silt seal layer (the skin) has been overestimated. The sealing of bare soils formed under high-energy rainfall cannot be attributed to the skin. The suggested theory allows the seal properties, including its thickness and hydraulic conductivity, to vary with respect to rain and soil properties as well as the flow boundary conditions. Seal thickness, hydraulic conductivity and conductance were calculated as a function of the driving hydraulic head for the two soils. The sandy loam had a thicker sealing layer with a higher hydraulic conductivity and sensitivity to flow conditions than the loam. While the hydraulic conductance of the loam seal decreased slowly as a function of the hydraulic gradient, the conductance of the sandy loam soil dropped sharply with an increase in the hydraulic gradient, and reached a lower value than that of the loam for large gradients. (See also W91-01872) (Author's abstract) W91-01873

## **2H. Lakes**

#### **MODELING LINKED WATERSHED AND LAKE PROCESSES FOR WATER QUALITY MANAGEMENT DECISIONS.**

Agricultural Research Service, Durant, OK.  
For primary bibliographic entry see Field 5G. W91-01012

#### **MOLYBDENUM AND SULFATE AS CONTROLS ON THE ABUNDANCE OF NITROGEN-FIXING CYANOBACTERIA IN SALINE LAKES IN ALBERTA.**

Cornell Univ., Ithaca, NY. Section of Ecology and Systematics.  
R. Marino, R. W. Howarth, J. Shames, and E. Prepas.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 245-259, March 1990. 4 fig, 6 tab, 60 ref. NSF Ecosystems Study Program Grant BSR 86-04688.

Descriptors: \*Alberta, \*Cyanophyta, \*Limiting nutrients, \*Limnology, \*Molybdenum, \*Nitrogen fixation, \*Saline lakes, \*Sulfates, Chemical analysis, Model studies, Nitrogen, Nutrient requirements, Phosphorus, Regression analysis, Statistical analysis.

Thirteen saline lakes in Alberta were studied to test the hypothesis that Mo availability influences the abundance of planktonic, N-fixing cyanobacteria in saline ecosystems. Earlier work in oxic seawater showed that the availability of Mo is controlled in part by the ratio of sulfate to Mo because sulfate inhibits the assimilation of molybdate. The sulfate:Mo ratio in seawater is very high relative to most freshwater lakes, a finding that is consistent with the scarcity of planktonic, N-fixing cyanobacteria in coastal marine ecosystems. This ratio is constant in seawater; however, limiting a test of this hypothesis in marine systems. The Alberta salt lakes provide a more robust test in saline systems. The ratio of sulfate to Mo within any given saline lake was relatively constant over a summer season, but the ratio between lakes varied and ranged from values typical of freshwater lakes to values higher than in seawater. N-fixing cyanobacteria are significant fractions of the plankton in six of the 13 lakes studied and are rare or absent in the others. The sulfate:Mo ratio was a strong predictor of the abundance of planktonic, N-fixing cyanobacteria. However, sulfate or Mo concentrations alone were not. This finding is consistent with the hypothesis that sulfate can control Mo availability in oxic waters. Phosphorus concentrations, and the ratio of N to P, were not good predictors of the abundance of N-fixing cyanobacteria in these saline lakes although they often are in freshwater lakes. The differences between predictions from a freshwater, P regression model and actual abundances of N-fixing cyanobacteria in the saline lakes were best explained by the sulfate:Mo ratio. (Author's abstract) W91-01034

#### **GROWTH AND VOLTINISM OF LOTIC MIDGE LARVAE: PATTERNS ACROSS AN APPALACHIAN MOUNTAIN BASIN.**

Georgia Univ., Athens. Dept. of Entomology.  
A. D. Huryn.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 339-351, March 1990. 6 fig, 6 tab, 36 ref. NSF Grants BSR 85-16497 and BSR 85-14328.

Descriptors: \*Appalachian Mountains, \*Aquatic insects, \*Midges, \*Stream biota, \*Temperature effects, Larvae, Life cycles, Regression analysis, Seasonal variation.

The influence of thermal regime upon community-level growth rates and voltinism was estimated for larval Chironomidae inhabiting litter accumulations in four streams located in an Appalachian Mountain basin. Groups of larvae were confined in growth chambers and incubated in situ at time intervals representing the observed range of annual thermal variation. Estimates of daily growth rates (g) were derived from change in average length

## Field 2—WATER CYCLE

### Group 2H—Lakes

over the incubation period. Using multiple regression, temperature and larval size were found to have significant positive and negative effects on  $g$ , respectively. Equations derived for each stream described a substantial proportion of the variance among observed  $g$  values ( $R^2 = 0.71-0.82$ ) but did not differ significantly. Therefore, the data from all streams were combined to derive a single general equation which, along with larval size distribution, biomass, and temperature data, was used to model the variation in annual biomass turnover ( $G$ ) and hypothetical size-dependent voltinism among the study streams. Size distribution of larvae did not differ significantly among streams and variation in  $G$  (range = 12.8-18.6) was attributed primarily to variation in thermal regime. Differences in voltinism were predicted to be minor, but were closely dependent on both terminal size of larvae and thermal regime. The model provides evidence that spatial variation of  $G$  on the order of 31% can be expected for midge communities within a < 30 square km area of this Appalachian Mountain basin. (Author's abstract)  
W91-01038

#### FLUXES AND TRANSFORMATION OF AQUATIC PIGMENTS IN LAKE MENDOTA, WISCONSIN

Wisconsin Univ.-Madison. Water Chemistry Program.

J. P. Hurley, and D. E. Armstrong.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 384-398, March 1990. 6 fig. 4 tab. 46 ref. NSF Grants DEB 80-12313 and EAR 88-16561.

Descriptors: \*Carotenoids, \*Chlorophyll, \*Lake sediments, \*Limnology, \*Pigments, \*Sediment chemistry, \*Sedimentation, \*Suspended solids, \*Wisconsin, Chemical analysis, Microbial degradation, Seasonal variation, Suspended sediments.

Concentrations and fluxes of chlorophyll and carotenoid pigments were measured in suspended and settling particulate matter and in surface sediments in Lake Mendota. Flux comparisons were used to calculate the extent of alteration or degradation within the water column and at the sediment surface. Losses within the water column for specific time intervals ranged from almost negligible for diatoxanthin to 96% for peridinin. The extent of loss was influenced by pigment type and transport process. Surface sediment diagenesis in Lake Mendota resulted in differential degradation rates among chlorophyll and carotenoid constituents. Deposition of pheophorbide  $a$ , a grazing indicator, was most important during late spring, as zooplankton populations increased and chlorophyll levels in the water column dropped below 1 nmol/liter. The ability to trace the magnitude of this annual event through the sedimentary record was obscured by selective degradation of pheophorbide relative to chlorophyll and pheophytin. Similarly, carotenoid composition was dramatically altered both within the water column and at the sediment surface. Fucoxanthin and peridinin, major water column carotenoids, were degraded extensively before incorporation in the sediments. (Author's abstract)  
W91-01041

#### MECHANISM FOR THE HYDROGEN SULFIDE-INDUCED GROWTH LIMITATION IN WETLAND MACROPHYTES

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.

M. S. Koch, I. A. Mendelsohn, and K. L. McKee.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 399-408, March 1990. 1 fig. 2 tab. 33 ref.

Descriptors: \*Hydrogen sulfide, \*Limnology, \*Macrophytes, \*Marshes, \*Wetlands, Adenosine triphosphate, Anoxic conditions, Enzymes, Fermentation, Marsh plants, Metabolism, Nitrogen cycle, Phytotoxicity, Plant growth, Respiration.

Hydrogen sulfide, a phytotoxin that often accumulates in anoxic marine and freshwater marsh soils, suppressed the activity of alcohol dehydrogenase (ADH), then enzyme that catalyzes the terminal step in alcoholic fermentation, in the roots of two wetland macrophytes. This inhibition of root ADH

activity with increasing sulfide concentration was associated with decreases in root total adenine nucleotide pool ( $ATP + ADP + AMP$ ), the adenylate energy charge ratio (AEC), nitrogen uptake (percent recovery of  $15NH_4^+$  as N) and growth (leaf elongation). These responses were species-specific with a greater negative impact in the freshwater marsh species that naturally inhabit low-sulfide environments. These findings lend support to the hypotheses that ADH activity, as a measure of fermentative metabolism, is important in maintaining the root energy status of wetland plants under hypoxic-anoxic conditions; that there is a significant negative effect of  $H_2S$  on the anoxic production of energy in these roots; and that an important negative effect of  $H_2S$  on plant growth is an inhibition of the energy-dependent process of N uptake. (Author's abstract)  
W91-01042

#### RAPID AMMONIUM CYCLING AND CONCENTRATION-DEPENDENT PARTITIONING OF AMMONIUM AND PHOSPHATE: IMPLICATIONS FOR CARBON TRANSFER IN PLANKTONIC COMMUNITIES

Texas Univ. at Austin, Port Aransas. Port Aransas Marine Lab.

C. A. Suttle, J. A. Fuhrman, and D. G. Capone.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 424-433, March 1990. 7 fig. 34 ref. NSF Grants OCE 84-10074, OCE 87-11132, OCE 84-17595, and OCE 85-15886.

Descriptors: \*Ammonium, \*Estuaries, \*Eutrophic lakes, \*Limiting nutrients, \*Limnology, \*Nutrient cycling, \*Organic carbon, \*Phosphates, \*Plankton, Marine environment, Nitrogen compounds, Nitrogen cycle, Nutrients, Radioisotopes, Seasonal variation, Size classes.

A short-lived radioactive isotope of nitrogen ( $N13$ , half-life = 10 min) of very high specific activity (> 100 mCi/micromole) was used to study  $NH_4^+$  uptake at near-ambient concentrations in natural planktonic communities. The turnover times of the dissolved  $NH_4^+$  pool in Long Island Sound ranged from tens of hours between April and early June to a fraction of an hour between mid-June and late July. The  $NH_4^+$  turnover time was also rapid in a nearby eutrophic lake. Up to 50% of the ambient  $NH_4^+$  flux into particulate material from Long Island Sound was attributable to organisms passing 1.0-micron polycarbonate filters. However, partitioning of  $NH_4^+$  uptake among size classes was very concentration-dependent. A 0.5 micromolar addition resulted in an increase in  $NH_4^+$  uptake by the > 3 micron size class of from 33% to > 80% of the total. Similar results were obtained for phosphate uptake into particulate matter from the Sargasso Sea. Although <20% of the ambient phosphate uptake was into particles > 1 micron, a 100 nanomolar pulse resulted in about 50% of the uptake entering the > 1 micron fraction. Because slight increases in  $NH_4^+$  and phosphate concentration result in greater uptake by larger organisms with higher C:N and C:P ratios, distributing these nutrients in 'patches' of elevated concentration results in more C being transferred to higher level consumers. (Author's abstract)  
W91-01043

#### DISTRIBUTION OF LABILE DISSOLVED ORGANIC CARBON IN LAKE MICHIGAN

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.

G. A. Laird, and D. Scavia.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 443-447, March 1990. 3 fig. 1 tab. 20 ref.

Descriptors: \*Aquatic bacteria, \*Carbon cycle, \*Dissolved organic carbon, \*Lake Michigan, \*Limnology, \*Nutrients, Lake stratification, Seasonal variation.

Identifying primary sources of labile dissolved organic carbon (LDOC) in pelagic systems has taken on new interest in light of recent evidence that a major portion of the C fixed via autotrophic production passes through heterotrophic bacteria and that much of the bacterial production is grazed.

This transfer of LDOC to primary consumers captures C that might otherwise be lost. Bioassay-measured LDOC concentrations were compared in near-bottom and near-surface Lake Michigan water between April and October 1986. In five of seven experiments, the LDOC concentration was higher in near-bottom water. LDOC reached 40.2% of the total DOC pool in the near-bottom water in late May and 13.8% in the near-surface water in early July. Concentration in near-bottom water was highest during early stratification; concentration in surface water varied less but was highest in early July. The data suggest that an allochthonous source of labile organic C may be important. Annual buildup of LDOC in the deep regions, which becomes available to the surface waters during winter mixing, may not make as significant a contribution to the system as was previously believed. At least in spring, allochthonous sources focused by the spring thermal front movement may contribute significantly to the LDOC pool and may help account for some of the previously-noted imbalance between bacterial and phytoplankton production. (Author's abstract)  
W91-01044

#### ALGAL USE OF SEDIMENTARY PHOSPHORUS FROM AN AMAZON FLOODPLAIN LAKE: IMPLICATIONS FOR TOTAL PHOSPHORUS ANALYSIS IN TURBID WATERS

California Univ., Santa Barbara. Dept. of Biological Sciences.

D. L. Engler, and O. Sarnelle.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 483-490, March 1990. 6 fig. 1 tab. 23 ref.

Descriptors: \*Algae, \*Amazon River, \*Lake sediments, \*Phosphorus, \*Turbidity, Bioassay, Bioavailability, Cycling nutrients, Laboratory methods, Nutrients, Sediment analysis.

Despite the potential influence of particulate-bound nutrients on the productivity of Amazon floodplain lakes, there is only one study addressing the bioavailability of particulate nutrients in this system. Chemical extraction techniques were coupled with a bioassay experiment to assess the types and amounts of bioavailable P present in the sediments of an Amazon floodplain lake. Chemical forms of P and their availabilities to *Selenastrum capricornutum* were measured in sediments collected from Lago Calado, an Amazon floodplain lake. Postbioassay analysis confirmed that *Selenastrum* used ca. 60-70% of the P in the NaOH-extracted fraction during a 9-d incubation. No evidence for algal use of Ca-bound P or organic P was found. Methodological comparisons revealed that persulfate digestion may not adequately recover algal-available particulate P in waters high in organic turbidity. An average of 26% of the algal-available P in Amazon River water was in particulate form. (Author's abstract)  
W91-01047

#### ABIOTIC TRANSFORMATIONS OF IRON AND PHOSPHATE IN HUMIC LAKE WATER REVEALED BY DOUBLE-ISOTOPE LABELING AND GEL FILTRATION

Limnologisch Inst., Oosterzee (Netherlands). Tjeu-kemeer Lab.

H. de Haan, R. I. Jones, and K. Salonen.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 491-497, March 1990. 5 fig. 1 tab. 19 ref.

Descriptors: \*Chemical interactions, \*Humic substances, \*Iron, \*Lakes, \*Limnology, \*Phosphates, Chemical complexes, Chromatography, Filtration, Finland, Iron radioisotopes, Laboratory methods, Phosphorus radioisotopes.

Abiotic transformations of Fe and phosphate in humic water from Finnish forest lakes were studied by Sephadex G-100 gel filtration following incubation of filtered (0.2 microns) epilimnetic water samples to which both  $Fe^{55}Cl_3-6H_2O$  and  $P^{32}O_4^{3-}$  had been added. The simultaneous movement of  $Fe^{55}$  and  $P^{32}$  to higher molecular weight fractions (10,000-20,000 MW) depended on the presence of dissolved humic substances (DHS). In the absence of DHS almost all  $Fe^{55}$ , probably

as inorganic hydrolyzed iron particles, sorbed to the Sephadex. The binding of Fe55 by DHS was not affected by increasing the natural ionic strength ( $I = \text{ca. } .0003 \text{ M}$ ) by a factor of 100. In the absence of quasi-equilibrium between free and DHS-bound  $\text{P32O4}^{3-}$ , the DHS-Fe- $\text{PO4}^{3-}$  complex readily released  $\text{P32O4}^{3-}$ -P. Compared to the  $\text{P32}$  binding, Fe55 binding was rapid. More than 20% of the Fe had been bound after only 1 min, whereas for labeled  $\text{PO4}^{3-}$  this percentage was reached only after 24 h. (Author's abstract) W91-01048

#### VARIABILITY OF DIATOM CONCENTRATIONS AND ACCUMULATION RATES IN SEDIMENTS OF A SMALL LAKE BASIN.

Sedimentology, London (England). Palaeoecology Research Unit.

N. J. Anderson. Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 497-508, March 1990. 7 fig, 4 tab, 36 ref.

Descriptors: \*Cores, \*Diatoms, \*Eutrophic lakes, \*Lake sediments, \*Limnology, Dating, Distribution patterns, Fossils, Lead radioisotopes, Northern Ireland, Sediment analysis, Sedimentation.

The use of fossil diatom assemblages to assist in reconstructing lake history and monitoring environmental change is a well-established procedure, however few studies have examined the variability of diatom assemblages in space and time. Diatom biostratigraphy was analyzed for 10 sediment cores covering a range of water depths in Lough Augher, Northern Ireland. Cores were zoned to permit correlation and transfer of a Pb210 chronology and calculation of diatom accumulation rates. There were clear differences in relative frequency of planktonic microfossils between littoral (< 6-m water depths) and profundal cores, but all cores gave a similar history of the eutrophication of the lake. Deep-water cores, however, provided a clearer and higher resolution record. Diatom concentrations and percentages were horizontally non-uniform, contradicting the assumption that lake and sediment mixing creates homogeneous microfossil assemblages before deposition. Accumulation rates also showed considerable variation over time. Relative accumulation rates indicate that no single core accurately reflects the mean accumulation rate for the whole basin. Before 1900, diatoms were focused into deeper water, but after ca. 1940 the pattern of diatom deposition and accumulation rates began to change. Redistribution of diatoms into the deepest part of the basin was reduced, perhaps due to reduced resuspension from the increasing influence of fringing macrophyte beds. (Author's abstract) W91-01049

#### GREIGITE AND THE MAGNETIC PROPERTIES OF SEDIMENTS.

Freshwater Biological Association, Ambleside (England). Windermere Lab.

J. Hilton. Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 509-520, March 1990. 7 fig, 1 tab, 29 ref.

Descriptors: \*Eutrophic lakes, \*Iron compounds, \*Lake sediments, \*Limnology, \*Magnetic studies, \*Paleolimnology, Chemical properties, Cores, England, Greigite, Lacustrine environment, Sediment analysis, Sulfides.

Measurements of the properties of magnetic minerals in lacustrine sediments have been used on many occasions to obtain information about relative accumulation rates in lakes and to study changes in erosion patterns in catchments. Data interpretation in such studies requires that an intensity extreme or direction change in one core is contemporary with a similar observation in another core. If magnetic minerals are formed in situ, this assumption could be invalid. X-ray diffraction spectra of freeze-dried sediments from a lake in the English Lake District positively identified the presence of greigite, a magnetic iron sulfide ( $\text{Fe}_3\text{S}_4$ ) mineral. The sediments also show considerable loss of magnetic intensity when wet samples are allowed to oxidize. Several hypotheses have been proposed elsewhere to explain the intensity loss, but an assessment of

the evidence suggests that oxidation of greigite is responsible in these sediments. Data from several lakes and from laboratory experiments are used to deduce the environmental requirements for greigite formation. These conditions of high labile C concentrations, good sources of labile Fe and S, and an oscillating oxycline depth in the sediments were likely to be found only in monomictic or dimictic eutrophic lakes, estuaries, and salt marshes and are unlikely to be found in meromictic lakes, unstratified lakes, oligotrophic lakes, or deep-sea sediments. (Author's abstract) W91-01050

#### CONTRIBUTION OF ORGANIC ACIDS TO ALKALINITY IN LAKES WITHIN THE MOUNT ST. HELENS BLAST ZONE.

Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.

R. C. Wissmar, D. M. McKnight, and C. N. Dahm. Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 535-542, March 1990. 3 fig, 4 tab, 27 ref. NSF Grants DEB 81-1307 and BSR 84-07429. U.S. Department of Agriculture Forest Service Agreement PNW-80-178.

Descriptors: \*Alkalinity, \*Geochemistry, \*Limnology, \*Mount St. Helens, \*Mountain lakes, \*Organic acids, \*Volcanoes, Alkaline water, Carbonates, Chemical properties, Chlorides, Dissolved organic carbon, Fulvic acids, Sulfates.

The volcanic eruption of Mount St. Helens in May 1980 severely affected lakes in the surrounding blast zone. Existing and newly formed lakes had high total alkalinities (TA) and concentrations of dissolved organic carbon (DOC). In Spirit Lake, TA and DOC were 36 and 64 times pre-eruption values. Dissolved organic acids, primarily ionized fulvic acids and hydrophilic acids constituted 80-90% of the dissolved organic material. High TA values during 1980 and 1981 included two major components, carbonate (CA) and surplus alkalinity. A comparison of minimal estimates for organic acid alkalinity from ionized fulvic acids and hydrophilic acids with values of surplus showed that the dissociation of organic acids contributed between 20 and 100% to alkalinity in 1980 and 1981. During 1981, surplus alkalinity and organic acid alkalinities relative to TA declined while CA increased. This increase in CA reflected the influence of dilution of lake volumes with runoff waters and a major decrease in organic acids due to dilution and microbial mineralization. CA appeared controlled by contributions of bicarbonate ions due to chemical weathering, possible anionic exchange and microbially mediated reactions. These reactions involving organic acids in combination with the geochemical characteristics of the eruption (e.g. moderate sulfate and chloride concentrations and massive loadings of inorganic and organic materials) led to well-buffered lakes that had a sizable proportion of the alkalinity being contributed by dissociated organic acids. (Author's abstract) W91-01051

#### PHYTOPLANKTON BIOMASS, PRODUCTION AND GROWTH LIMITATIONS ON THE HUANGHE (YELLOW RIVER) CONTINENTAL SHELF.

Louisiana State Univ., Baton Rouge. Coastal Ecology and Fisheries Inst.

For primary bibliographic entry see Field 2L. W91-01058

#### CADMIUM CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON OF ACIDIFIED AND NONACIDIFIED CANADIAN SHIELD LAKES.

Guelph Univ. (Ontario). Dept. of Zoology.

For primary bibliographic entry see Field 5B. W91-01062

#### MERCURY SPECIATION IN SURFACE FRESHWATER SYSTEMS IN CALIFORNIA AND OTHER AREAS.

California Univ., Santa Cruz. Inst. of Marine Sciences.

For primary bibliographic entry see Field 2K. W91-01063

#### ENVIRONMENTAL FACTORS AFFECTING THE PRODUCTION OF PEPTIDE TOXINS IN FLOATING SCUMS OF THE CYANOBACTERIUM MICROCYSTIS AERUGINOSA IN A HYPERTROPHIC AFRICAN RESERVOIR.

Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.

R. J. Wicks, and P. G. Thiel. Environmental Science and Technology ESTHAG, Vol. 24, No. 9, p 1413-1418, September 1990. 3 fig, 2 tab, 45 ref.

Descriptors: \*Biological pollution, \*Cyanophyta, \*Eutrophication, \*Peptides, \*South Africa, \*Toxins, \*Water pollution sources, Chemical analysis, Chlorophyll a, Eutrophic lakes, Hartbeespoort Dam, Hydrogen ion concentration, Liquid chromatography, Oxygen, Pollutant identification, Primary productivity, Reservoirs, Seasonal variation, Solar radiation, Water temperature.

The presence of six cyclic, heptapeptide toxins in floating scums of *Microcystis aeruginosa* in Hartbeespoort Dam, South Africa, was monitored over 2.5 years. Separation of the six peptide toxins was achieved by reverse phase high pressure liquid chromatography. The six toxins were either not detectable or in very low concentrations during the summer. Combined concentrations of four of the toxins ranged from 5 to 415 micrograms/gram of dry scum and were strongly and positively correlated to primary production per unit of chlorophyll-a, solar radiation, surface water temperature, pH, and percent oxygen saturation ( $r = 0.52-0.67$ ,  $n = 16-20$ ,  $p < 0.001$ ) and weakly, negatively correlated to surface chlorophyll-a and orthophosphate concentrations ( $r = -0.33$ ,  $n = 16-20$ ,  $p < 0.05$ ). No strong relationships were found between total toxin concentrations in scum samples and surface water organic and inorganic nutrient concentrations. The data from the subtropical reservoir indicated that the specific rate of photosynthesis of *M. aeruginosa* together with several environmental factors is closely coupled to the concentrations of peptide toxins in this cyanobacterium. (Author's abstract) W91-01065

#### SEASONAL VARIATIONS OF POPULATION DENSITY AND ACTIVITY OF SULFATE-REDUCING BACTERIA IN OFFSHORE AND REED SEDIMENTS OF A HYPERTROPHIC FRESHWATER LAKE.

Tokyo Metropolitan Univ. (Japan). Dept. of Biology.

M. Fukui, and S. Takii. Japanese Journal of Limnology RIZAAU, Vol. 51, No. 2, p 63-71, April 1990. 8 fig, 1 tab, 22 ref.

Descriptors: \*Eutrophic lakes, \*Lake Teganuma, \*Lake sediments, \*Limnology, \*Population density, \*Seasonal variation, \*Sulfur bacteria, Japan, Reeds, Sulfates, Water temperature.

Seasonal variations in population density of sulfate-reducing bacteria (SRB) and sulfate reduction rates were examined for sediments of an offshore and reed site of Lake Teganuma (freshwater, hypertrophic), Chiba Prefecture, Japan. The numbers of SRB (colony forming units/ml) in the surface sediments (0-2 cm) were at a level of 100,000 at the reed site and a level of 10,000 at the offshore one, and they remained relatively constant throughout the year. The activities at both sites increased from summer to autumn, and the reed sediments showed higher activities (1.08-16.6 times) than the offshore ones in this period; the maximum rates (September) (nmol/ml/day) in the offshore and reed sediments were 290 in the 0-3 cm layer and 1990 in the 3-6 cm layer. In situ temperature may have greatly affected sulfate reduction. (Author's abstract) W91-01072

#### IMPORTANCE OF NATURAL PROCESSES IN UNDERSTANDING ECOSYSTEM CHANGE: A CASE STUDY OF LIMED LAKES.

Illinois State Water Survey Div., Champaign.

E. C. Krug, and A. S. Lefohn. Journal of the Air & Waste Management Association, Vol. 40, No. 6, p 846-854, June 1990. 1 fig, 4

## Field 2—WATER CYCLE

### Group 2H—Lakes

tab, 56 ref.

Descriptors: \*Acid rain, \*Case studies, \*Ecosystems, \*Lake restoration, \*Liming, \*Limnology, Adirondack lakes, Chemical interactions, Dissolved organic carbon, Hydrogen ion concentration, Ion exchange, Lakes, Land use, Sphagnum moss, Sulfates, Water chemistry.

A review of the lake chemistry from six lakes studied has identified possible important areas for further investigation. First, weak acids in sediment that titrate the lime added to a lake may represent a potentially important process that requires further quantification. Second, the chemistry and biological processes involving Sphagnum or other ion exchange processes are of interest for assessing the potential importance of ecosystems to contribute strong acids to their watersheds. Third, independent sources of hydrogen and sulfate ions not associated with atmospheric deposition may exist in lakes. Fourth, DOC and pH appear to be positively correlated for the Adirondack lakes studied. Accordingly, if processes have recently acidified these Adirondack lakes, then concentrations of DOC may have been greater in the past. Thus, these Adirondack lakes may have been acidified by organic acids in the past to a greater degree than indicated by present-day water chemistry. A number of possible processes (land use, clear cutting, burning, forestry, and loss of alkaline nutrient substances from watersheds) may play important roles in acidifying surface waters. However, many of these processes are poorly understood and require further research. (Lantz-PTT)  
W91-01073

**BERSANI V. EPA: TOWARD A PLAUSIBLE INTERPRETATION OF THE 404(B)(1) GUIDELINES FOR EVALUATING PERMIT APPLICATIONS FOR WETLAND DEVELOPMENT.**  
For primary bibliographic entry see Field 5G.  
W91-01092

**EFFECTS OF LAKE ACIDIFICATION ON AQUATIC MACROPHYTES—A REVIEW.**  
Imperial Coll. at Silwood Park, Sunninghill (England). Dept. of Biology.  
For primary bibliographic entry see Field 5C.  
W91-01105

**NUTRIENT DYNAMICS IN A FLOATING MAT AND POND SYSTEM WITH SPECIAL REFERENCE TO ITS VEGETATION.**  
Kyoto Univ. (Japan). Lab. for Plant Ecological Studies.  
A. Haraguchi, and K. Matsui.  
Ecological Research (Kyoto) ECRSEX, Vol. 5, No. 1, p 63-79, April 1990. 12 fig, 1 tab, 29 ref.

Descriptors: \*Cycling nutrients, \*Floating plants, \*Limnology, \*Nutrient transport, \*Ponds, \*Sphagnum, Floating mat, Hydrogen ion concentration, Peat, Seasonal variation, Vegetation effects.

Chemical properties of waters and their seasonal changes were studied in Mizorogaike Pond, a system of pond and floating mat. The following six sites including contrasting habitats and water conditions were monitored to assess nutrient dynamics in the system: (1) a pool on the mat, (2) margin of a Sphagnum cuspidatum community, (3) an artificial 'well' (water layer beneath the floating mat), (4) a Menyanthes trifoliata community in a hollow, and (5) and (6) two sites in the open water. On the floating mat, the water around the Sphagnum community had lower pH values, while that in the M. trifoliata community had higher pH values. This difference was related to the influence of flood water, the extent of which was determined by the microtopography. Seasonal changes in water chemistry on the mat suggested that pond water flooding the mat in late autumn and winter is important for the nutrient supply to the mat surface vegetation in this system. Water chemistry of the 'well' suggested that the diffusion of inorganic nitrogen occurs from beneath the peat layer. Two types of cluster analysis based on the mean values for chemical variables and the patterns of fluctuation in these variables were performed. The six

sites were classified into similar groups which were identified by water type (pool, hollow, well and open water) by both types of analysis. The results showed that a common kind of perturbation should operate in determining the status of nutrient dynamics in the various water types. (Author's abstract)  
W91-01126

**MACROINFAUNAL COMMUNITY OF A TROPICAL ESTUARINE LAGOON.**  
Center for Energy and Environment Research, Mayaguez, PR.  
For primary bibliographic entry see Field 2L.  
W91-01133

**STRUCTURE AND FUNCTION OF DRY WEATHER MANGROVES ON THE PACIFIC COAST OF CENTRAL AMERICA, WITH EMPHASIS ON AVICENNIA BICOLOR FORESTS.**  
Universidad Nacional Autonoma de Heredia (Costa Rica). Escuela Ciencias Biologicas.  
For primary bibliographic entry see Field 2L.  
W91-01134

**VARIABILITY OF MANGROVE ECOSYSTEMS ALONG THE BRAZILIAN COAST.**  
Sao Paulo Univ. (Brazil). Inst. Oceanografico.  
For primary bibliographic entry see Field 2L.  
W91-01136

**MANGROVE ECOLOGY, AQUATIC PRIMARY PRODUCTIVITY, AND FISH COMMUNITY DYNAMICS IN THE TEACAPAN-AGUA BRAVA LAGOON-ESTUARINE SYSTEM (MEXICAN PACIFIC).**  
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnologia.  
F. Flores-Verdugo, F. Gonzalez-Farias, O. Ramirez-Flores, F. Amezcua-Linares, and A. Yanez-Arancibia.  
Estuaries ESTUDO, Vol. 13, No. 2, p 219-230, June 1990. 6 fig, 4 tab, 51 ref.

Descriptors: \*Fish populations, \*Mangrove swamps, \*Population dynamics, \*Species diversity, Biomass, Coastal areas, Mexico, Primary productivity, Seasonal variation.

Aquatic primary productivity, mangrove ecology, and fish community dynamics were investigated in the Teacapan-Agua Brava lagoon-estuarine system, the most extensive mangrove ecosystem on the Pacific coast of Mexico with three species of mangroves distributed heterogeneously (Laguncularia racemosa, Rhizophora mangle, and Avicennia germinans). Tree density was 3,203 trees/ha and basal area was 14.0 sq m/ha. Litterfall was 1,417 g/sq m/yr, characteristic of a productive riverine forest. The degradation constant for Laguncularia racemosa leaves varied from 1.71 to 4.7/yr and mean annual net aquatic productivity was 0.41 g C/cu m/d. There were high concentrations of humic substances (up to 150 mg/l) early in the wet season. Seasonal variations of the above parameters seemed closely related to the ecology of fish populations. There were 75 fish species distributed in two principal assemblages associated with wet and dry seasons. Diversity and biomass analysis indicated 18 dominant species. Total biomass of the community in this coastal system was estimated at 10 g wet wt/sq m. The highest biomass occurred in the wet season. The most common fish species were Mugil curema, Achirus mazatlanus, Galeichthys caeruleus, Arius liropus, Diapterus peruvianus, Lile stollera, Centropomus robalo, and Eucinostomus sp., all of which have fishery importance. Primary productivity and fish community ecology are controlled by habitat characteristics, river discharge, and climatic seasonality. (Author's abstract)  
W91-01137

**EVALUATION OF BIOLOGICALLY HARMFUL ULTRAVIOLET RADIATION IN ANTARCTICA WITH A BIOLOGICAL DOSIMETER DESIGNED FOR AQUATIC ENVIRONMENTS.**

California Univ., San Francisco. Lab. of Radiobiology.  
For primary bibliographic entry see Field 7B.  
W91-01138

**MICROALGAL GROWTH MODEL.**  
Hawaii Univ., Honolulu. Dept. of Oceanography.  
For primary bibliographic entry see Field 2L.  
W91-01140

**DENITRIFICATION IN NITRATE-RICH STREAMS: DIURNAL AND SEASONAL VARIATION RELATED TO BENTHIC OXYGEN METABOLISM.**  
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.  
P. B. Christensen, L. P. Nielsen, J. Sorensen, and N. P. Revsbech.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 640-651, May 1990. 6 fig, 44 ref.

Descriptors: \*Biodegradation, \*Denitrification, \*Eutrophic streams, \*Fate of pollutants, \*Limnology, \*Model studies, \*Streams, Chlorophyll, Diffusion, Nitrates, Oxygen, Photosynthesis.

Seasonal variation of chlorophyll content, photosynthesis, O<sub>2</sub> respiration, and denitrification was measured under light and dark conditions in the sediment of a nutrient-rich Danish lowland stream. Exponential growth of benthic microalgae was observed in early spring (April-May) and photosynthetic capacity persisted until fall. The benthic algae were a major C source for heterotrophic activity as indicated by a close correlation between O<sub>2</sub> respiration and Chl content in the sediment. Denitrification activity was related to Chl content, NO<sub>3</sub>-availability, and O<sub>2</sub> conditions. Diffusion from the overlying water was always the major NO<sub>3</sub>-source for denitrification. Under lighted conditions, photosynthetic O<sub>2</sub> production increased the oxic zone and reduced denitrification activity by up to 85% in spring. A simple diffusion-reaction model allowed denitrification rates to be estimated from O<sub>2</sub> respiration rates and concentrations of O<sub>2</sub> and NO<sub>3</sub>(-) in the stream water. Throughout the season, estimated denitrification rates correlated well with those actually measured. The model demonstrated that denitrification activity was controlled primarily by the thickness of the oxic surface layer which served as a diffusion barrier for NO<sub>3</sub>(-) to the denitrification zone. (Author's abstract)  
W91-01142

**COMPARISON OF THE ACIDIFICATION EFFICIENCIES OF NITRIC AND SULFURIC ACIDS BY TWO WHOLE-LAKE ADDITION EXPERIMENTS.**  
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.  
For primary bibliographic entry see Field 5B.  
W91-01143

**SEASONAL PATTERNS OF GRAZING AND NUTRIENT LIMITATION OF PHYTOPLANKTON IN A EUTROPHIC LAKE.**  
Wisconsin Univ.-Madison. Center for Limnology.  
M. J. Vanni, and J. Temte.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 697-709, May 1990. 3 fig, 3 tab, 24 ref.  
Federal Aid in Sport Fish Restoration Act Project F-95-P.

Descriptors: \*Eutrophic lakes, \*Grazing, \*Lake Mendota, \*Limiting nutrients, \*Limnology, \*Phytoplankton, Biomass, Daphnia, Nitrogen, Phosphorus, Seasonal variation, Succession, Wisconsin.

Observations and experiments on zooplankton grazing and nutrient (N and P) limitation of phytoplankton of Lake Mendota, Wisconsin, revealed that the relative strength of the two factors varied markedly during the seasonal succession of phytoplankton. Furthermore, seasonal changes in grazing and nutrient limitation were caused not only by seasonal changes in zooplankton community structure and nutrient availability but also by changes in

phytoplankton community structure, which led to changes in edibility to zooplankton. The spring phytoplankton bloom of diatoms and small flagellates was highly vulnerable to grazing by both cyclopoid copepods and *Daphnia*, although *Daphnia* had a much stronger effect. Increased *Daphnia* grazing in late spring resulted in low phytoplankton biomass (the clear-water period) and a phytoplankton community dominated by colonial green algae—taxa vulnerable to grazing by *Daphnia* but not other zooplankton. Nutrients (N and P) did not limit phytoplankton growth during the spring bloom or the clear-water period. After the clear-water period, the summer phytoplankton community was dominated by blue-greens and *Ceratium*. Grazing effects by both *Daphnia* and copepods were low in summer, while nutrient limitation (both N and P) became severe. Reduced grazing impacts in summer may have resulted from prior intense grazing impacts, which led to dominance of grazing-resistant taxa. These results suggest that seasonal variation in the strength of grazing and nutrient controls in eutrophic lakes results from changes in zooplankton biomass and community structure, nutrient availability, and phytoplankton community structure interacting to determine phytoplankton seasonal succession. (Author's abstract) W91-01144

#### EPIPHYTIC ALKALINE PHOSPHATASE ON NATURAL AND ARTIFICIAL PLANTS IN AN OLIGOTROPHIC LAKE: RE-EVALUATION OF THE ROLE OF MACROPHYTES AS A PHOSPHORUS SOURCE FOR EPIPHYTES.

North Carolina State Univ. at Raleigh. Dept. of Botany.

J. M. Burkholder, and R. G. Wetzel.

Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 736-747, May 1990. 2 fig, 1 tab, 46 ref.

Descriptors: \*Enzymes, \*Epiphytes, \*Limnology, \*Macrophytes, \*Oligotrophic lakes, Chlorophyll a, Phosphates.

Alkaline phosphatase activity (APA) and Chl a concentrations of epiphytes were measured from two species of aquatic macrophytes (*Potamogeton illinoensis* and *Scirpus subterminalis*) and structurally similar artificial plants in a P-limited lake. The artificial substrata were incubated serially in situ to simulate the age of the natural plant leaves. Throughout the macrophyte growing season, APA per unit of algal Chl on both new and aging leaves was consistently greater for intact epiphytes on artificial plants. This enhancement increased 2-fold to 20-fold (mean 4.5-fold and 7.4-fold for epiphytes from natural and artificial plants) when epiphytes were removed from the plants and suspended before enzymatic assay, exposing more algal cells to the amended PO<sub>4</sub>(<sup>3-</sup>) substrate. Comparisons of APA for epiphytes on natural and artificial plants indicated that in this oligotrophic lake, submersed macrophytes were a source of P for epiphytes throughout the growing season and significantly influenced the P metabolism of the microflora. Epiphyte Chl was significantly greater from artificial than from natural plants in 6 of 11 comparisons, however, perhaps indicating a trade-off between improved P availability and some nonbeneficial factor associated with the macrophyte. (Author's abstract) W91-01146

#### ANOMALOUS TEMPERATURE AND OXYGEN GRADIENTS UNDER THE ICE OF A HIGH-PLAINS LAKE IN WYOMING.

Wyoming Univ., Laramie. Dept. of Zoology and Physiology.

F. J. Rahel.

Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 751-755, May 1990. 3 fig, 17 ref. NSF Grant BSR-88-07200.

Descriptors: \*Density stratification, \*Iced lakes, \*Limnology, \*Mountain lakes, \*Oxygen, \*Environmental gradient, \*Temperature gradient, Gelati Lake, Wyoming.

Temperatures up to 7.0 C and unusual oxygen profiles were observed under the ice of Gelati Lake, Wyoming. A layer of warm water near the

lake bottom appeared to result from solar heating of bottom sediments. Local increases in the oxygen profile were present in association with a bed of rooted macrophytes (*Chara* spp.) and a layer of phytoplankton just above bottom. This unusual stratification appeared to be maintained by density differences imposed by a gradient of dissolved solids from surface to bottom. Persistence of a layer of elevated oxygen concentrations, maintained by the stable density stratification, may explain the successful overwintering of fish in this lake. (Author's abstract) W91-01148

#### WATER QUALITY EVALUATION IN LAKES OF GREECE.

National Centre for Marine Research, Athens (Greece).

T. S. Koussouris, G. D. Photis, A. C. Diapoulis,

and I. T. Bertahas.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 119-128, 5 fig, 4 tab, 14 ref.

Descriptors: \*Eutrophication, \*Greece, \*Lakes, \*Limnology, \*Water quality, Agricultural runoff, Ammonia, Eutrophic lakes, Mesotrophic lakes, Nitrates, Nutrients, Oligotrophic lakes, Phosphorus, Trophic level.

Recent limnological investigations carried out by the Institute of Inland Waters in Greece provided information on the morphological features of the natural lakes, their physicochemical characteristics and nutrient framework. Water quality, trophic status and the natural background trophic level were evaluated with regard to the water bodies' uses. Based on the available physical, chemical and biological parameters, the Greek lakes could be categorized into: warm, monomictic and deep lakes with oligotrophic to oligomesotrophic and mesotrophic conditions mainly affected by non-point sources of nutrients; dimictic and shallow lakes with eutrophic to hypertrophic situations due to sewage discharges directly into the basin and oligomesotrophic with natural and agricultural enrichment of their waters; and warm, monomictic and shallow lakes with eutrophic to hypertrophic conditions resulting mainly from agricultural run-offs and point sources of pollution. High concentrations of ammonia, nitrate and phosphate are found in many lakes, while anaerobic hypolimnia are usually encountered in the shallow ones. Phosphorus is the main factor responsible for the eutrophication processes because it is the limiting factor in most examined lakes. The phosphorus retention coefficient, loading and its permissible level have been also calculated in some of the Greek lakes. The oscillations of the water level, the runoffs from agricultural activities and the wastewater discharges, have an increasing deleterious effect on the water quality and interfere directly with the uses of water, such as fishery, irrigation, and amenities. (See also W91-01211) (Author's abstract) W91-01212

#### EUTROPHICATION: ASSESSMENT, RESEARCH AND MANAGEMENT WITH SPECIAL REFERENCE TO SCOTLAND'S FRESHWATERS.

Institute of Terrestrial Ecology, Edinburgh (Scotland).

For primary bibliographic entry see Field 5C.

W91-01277

#### MACROINVERTEBRATE COMMUNITY RESPONSES TO COPPER IN LABORATORY AND FIELD EXPERIMENTAL STREAMS.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.

For primary bibliographic entry see Field 5C.

W91-01312

#### DECOMPOSITION OF ROOTS IN A SEASONALLY FLOODED SWAMP ECOSYSTEM.

Old Dominion Univ., Norfolk, VA. Dept. of Biological Sciences.

E. G. Tupacz, and F. P. Day.

Aquatic Botany AQBODS, Vol. 37, No. 3, p 199-214, August 1990. 3 fig, 3 tab, 35 ref. NSF Grant BSR-8405222.

Descriptors: \*Decomposition, \*Great Dismal Swamp, \*Roots, \*Swamps, \*Wetlands, Annual floods, Decay rates, Detritus, Environmental effects, Forests.

Decomposition rates of roots to a depth of 40 cm were estimated by two methods in four plant communities in the periodically flooded Great Dismal Swamp. The community dominants were: (1) *Chamaecyparis thuyoides*; (2) *Taxodium distichum*; (3) mixed *Quercus* spp. and (4) *Acer rubrum*-*Nyssa* spp. respectively. Modified litter bags and a core method were simultaneously employed on three flooded sites and an unflooded site. Long vertical litter bags were developed to measure root decay over a vertical soil profile with minimal disturbance to the soil. Reciprocal samples (litter from each of the other sites) were placed on each site to examine the effects of litter quality. Roots in the cores exhibited higher decay rates than in the litter bags; rates in the bags ranged from 0.48 to 1.00 mg/g/d and the range for the cores was 1.15-2.74 mg/g/d. The core method was ineffective in estimating decay rates for the > 5 mm diameter roots because of high sample variability. Reciprocal samples revealed statistically significant differences between root types, with roots from the mixed *Quercus* site being most resistant to decay. Just as leaf litter quality has been shown to regulate above-ground decomposition, root quality appears to play a major role in belowground decay. The study also demonstrated the importance of environmental influences since root decay was slowest on the sites (*Chamaecyparis* and *Acer-Nyssa*) with the longest duration of soil saturation. Both techniques exhibited slow decay rates with increasing depth. The litter bag technique is the recommended approach; several problems make the core technique a less than satisfactory method. (Author's abstract) W91-01331

#### DECOMPOSITION RATE, CHEMICAL COMPOSITION AND NUTRIENT RECYCLING OF NYMPHAEA ALBA L. FLOATING LEAF BLADE DETRITUS AS INFLUENCED BY PH, ALKALINITY AND ALUMINIUM IN LABORATORY EXPERIMENTS.

Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.

C. J. Kok, H. W. G. Meesters, and A. J. Kemper.

Aquatic Botany AQBODS, Vol. 37, No. 3, p 215-227, August 1990. 3 fig, 4 tab, 45 ref.

Descriptors: \*Acid rain effects, \*Alkalinity, \*Aquatic plants, \*Cycling nutrients, \*Decomposition, \*Hydrogen ion concentration, \*Water pollution effects, Acidic water, Bicarbonates, Calcium, Detritus, Lake restoration, Lake sediments, Magnesium, Nitrogen, Organic matter, Phosphorus.

Decomposition experiments were carried out in chemostats, using synthetic media, to investigate the influence of pH, Al and HCO<sub>3</sub>(-) concentrations on the decomposition and chemical composition of floating leaf material of *Nymphaea alba* L. Low pH and elevated Al concentrations inhibited decay. High HCO<sub>3</sub>(-) concentrations stimulated decomposition. N concentration in the detritus increased in all media, but more so in the non-acid treatments. In media containing HCO<sub>3</sub>(-), Ca and Mg concentration rose in the decaying material. In acid media, these elements disappeared rapidly from the detritus. N and P recycling from the detritus was slower in acid media because of the lower overall decay rate. The low decay rate in acid waters will lead to a slow recycling of nutrients from the decomposing plant material. A relatively large part of the N and P in acid systems will be located in organic matter on the bottom and is therefore not available for primary production. This also has consequences for the restoration of acidified systems with accumulated organic matter deposits. Addition of lime or other acid-neutralizing substances can lead to a sharp increase

## Field 2—WATER CYCLE

### Group 2H—Lakes

in decay rate and a rapid release of N and P from the detritus. Removal of the organic layer from the sediment may be a prerequisite for the restoration of an acidified water to the former oligotrophic situation. (White-Reimer-PTT)  
W91-01332

**SPIROGYRA SPECIES AND ACCOMPANYING ALGAE FROM POOLS AND DITCHES IN THE NETHERLANDS.**  
Vrije Univ., Amsterdam (Netherlands). Biological Lab.  
For primary bibliographic entry see Field 5C.  
W91-01333

**ADVANCES IN ESTIMATING BACTERIAL BIOMASS AND GROWTH IN AQUATIC SYSTEMS.**  
Vandkultetitsinstituttet, Hoersholm (Denmark).  
For primary bibliographic entry see Field 5A.  
W91-01334

**EPIPLANKTONIC CARBON FLUX AND TURNOVER OF DIFFERENT PARTICLE SIZE CLASSES IN OLIGO-MESOTROPHIC LAKE LUCERNE, SWITZERLAND.**  
Eidgenössische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewässerschulz, Dübendorf (Switzerland). Inst. of Aquatic Sciences.  
For primary bibliographic entry see Field 5B.  
W91-01335

**PHOSPHATE (32P)-UPTAKE CAPABILITIES OF NATURAL PICOPLANKTON AND ULTRAPLANKTON COMMUNITIES IN LAKES OF DIFFERING DEGREES OF EUTROPHICATION.**  
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Abt. Oekophysiologie.  
For primary bibliographic entry see Field 5C.  
W91-01336

**LONG TERM PATTERNS IN NUTRIENTS, PHYTOPLANKTON AND ZOOPLANKTON OF LAKE KINNERET AND FUTURE PREDICTIONS FOR ECOSYSTEM STRUCTURE.**  
Kinneret Limnological Lab., Tiberias (Israel).  
For primary bibliographic entry see Field 5C.  
W91-01337

**EPIPHYTIC ZOOBENTHOS DENSITY AND BIOMASS WITHIN LOW ALKALINITY, OLIGOTROPHIC LAKES ON THE CANADIAN SHIELD.**  
Toronto Univ. (Ontario). Inst. for Environmental Studies.  
For primary bibliographic entry see Field 5C.  
W91-01338

**MICRO-ARTHOPOD SEASONALITY IN STREAMS OF VARYING PH.**  
Queen Mary Coll., London (England). School of Biological Sciences.  
S. D. Rundle.  
Freshwater Biology FWBLAB, Vol. 24, No. 1, p 1-21, August 1990. 10 fig, 5 tab, 40 ref.

Descriptors: \*Acidic water, \*Aquatic animals, \*Benthic fauna, \*England, \*Hydrogen ion concentration, \*Stream biota, \*Aluminum, \*Biological samples, \*Calcium, \*Conductivity, \*Copepods, \*Population density, \*Seasonal variation, \*Species composition, \*Species diversity, \*Statistical analysis, \*Waterfleas, \*Watermites.

Micro-arthropods were sampled seasonally (January, May, August, and October) during 1986 from ten stony riffle sites on streams in the Ashdown Forest of southern England, using both standard benthic and interstitial samplers. Total densities peaked at most sites in summer. Species richness reached a maximum at acid sites in summer but at circumneutral sites in autumn, when Hydrachnellae and Cladocera were particularly species rich. Individual species showed no obvious differences in seasonality between sites; the majority peaking

in summer or autumn, regardless of pH. However, cyclopoid copepods were particularly numerous at acid sites in summer, a pattern not observed at circumneutral sites. Multivariate ordination and classification of data sets from the separate seasons, and all four seasons combined, showed that mean site pH, conductivity, and aluminum and calcium concentrations were the most important variables explaining between-site variation in species composition. This clear distinction between the community structure at acidic and circumneutral sites was evident in all seasons except winter. Species composition was also more predictable throughout the year at low-pH sites. A number of species were taken consistently in interstitial samples and the cyclopoids Diacyclops languidus and D. languidioides were restricted to the hyporheos at circumneutral sites. The similar faunal composition of the hyporheos and the epibenthos indicated that the separation of these communities was not well defined in Ashdown Forest streams. (Author's abstract)  
W91-01339

**DISSOLVED ORGANIC CARBON CONCENTRATIONS AND FLUXES ALONG THE MOISIE RIVER, QUEBEC.**  
University Coll. of North Wales, Bangor. School of Animal Biology.  
For primary bibliographic entry see Field 2K.  
W91-01341

**REFUGE AVAILABILITY: A KEY TO UNDERSTANDING THE SUMMER DISAPPEARANCE OF DAPHNIA.**  
Minnesota Univ., Minneapolis. Limnological Research Center.  
D. Wright, and J. Shapiro.  
Freshwater Biology FWBLAB, Vol. 24, No. 1, p 43-62, August 1990. 9 fig, 1 tab, 64 ref.

Descriptors: \*Animal behavior, \*Daphnia, \*Lake ecology, \*Limnology, \*Predation, \*Waterfleas, \*Zooplankton, \*Community structure, \*Dissolved oxygen, \*Fish, \*Light quality, \*Mortality, \*Natality, \*Refuge availability, \*Seasonal variation, \*Temperature.

The mid-summer declines of Daphnia species in three small lakes were investigated to examine the relative roles of reduced natality and increased mortality. Reduced natality (assessed by quantifying clutch size, lipid index, and available food) could not account for the decline in daphnid abundance in any of the populations examined. The role of increased mortality imposed by zooplanktivorous fish was assessed by estimating the sizes of the mid-water refuge areas where daphnids could escape fish predation. Mid-water refugia can be formed in lakes in either of two ways. (1) A physical or chemical gradient (e.g., temperature or dissolved oxygen) might act by restricting the vertical distribution of the predator so that spatial separation between predator and prey populations occurs. (2) Alternatively, a gradient in light intensity or cover density could act by reducing the rate of predation where overlap of the populations does occur. The boundaries of the refuge areas were estimated from field measurements and literature values and were based on gradients of temperature, dissolved oxygen and light. Observed decreases in refuge thicknesses correlated well with the mid-summer declines of large-bodied Daphnia species in all three lakes. Intermediate-sized daphnids were less affected as the refuges thinned and small-bodied species increased in abundance. The importance of refuge thickness in modifying zooplanktivore-induced mortality was further tested in large enclosures where refuge thickness was experimentally modified. In the presence of zooplanktivorous fish, large-bodied Daphnia, which used the refuge, persisted when the refuge was thick but disappeared when it thinned. Daphnia galeata mendotae, which did not occupy the refuge zone, was rapidly eliminated regardless of refuge thickness. It was concluded that refuge availability plays a major role in Daphnia population dynamics. (White-Reimer-PTT)  
W91-01342

**ECOLOGY OF TWO INTERMITTENT STREAMS IN VICTORIA, AUSTRALIA. I. MULTIVARIATE ANALYSES OF PHYSICO-CHEMICAL FEATURES.**  
Monash Univ., Clayton (Australia). Centre for Stream Ecology.  
For primary bibliographic entry see Field 2E.  
W91-01344

**INHIBITORY EFFECTS OF HIGH MOLECULAR WEIGHT DISSOLVED ORGANIC MATTER UPON METABOLIC PROCESSES IN BIOFILMS FROM CONTRASTING RIVERS AND STREAMS.**  
University Coll. of North Wales, Bangor. School of Biological Sciences.  
For primary bibliographic entry see Field 2K.  
W91-01345

**MODELLING BLACK FLY PRODUCTION DYNAMICS IN BLACKWATER STREAMS.**  
Alabama Univ., University. Aquatic Biology Program.  
A. C. Benke, and K. A. Parsons.  
Freshwater Biology FWBLAB, Vol. 24, No. 1, p 167-180, August 1990. 7 fig, 3 tab, 37 ref. NSF (DEB-8104427, BSR-8406630, BSR-8705745).

Descriptors: \*Aquatic insects, \*Black flies, \*Georgia, \*Model studies, \*Population dynamics, \*Productivity, \*Stream ecology, \*Biomass, \*Black Creek, \*Flooding, \*Habitats, \*Hydrographs, \*Ogeechee River, \*Satilla River, \*Snags, \*Temperature.

Two predictive models were employed along with intensive field sampling to estimate production of black flies (Simulium spp.) on snags (submerged wood) in three blackwater streams on the Georgia Coastal Plain of the Southeastern U.S. One model predicts daily growth rate from temperature and hydrograph pattern; the other predicts habitat abundance (of snags) from river height. In the sixth order Ogeechee River, annual production was twice as high in 1982 (7.1 g dry mass (=DM)/sq m) as in 1983 (3.6 g DM/sq m). When converted to production per sq m of river bottom, values were 35-40% of the snag surface estimates. Annual production was much lower in fourth order Black Creek (1982, 1.3 g DM/sq m of snag surface) and much higher in the sixth order Satilla River (1975, 15.6-40.0 g DM/sq m). There was a distinct bimodal pattern of black fly production in the Ogeechee River in both years, with peaks occurring in winter and summer. Similar bimodal patterns of production were found in Black Creek and in the Satilla River. Although there appears to be an intrinsic component to the bimodal pattern, production peaks (growth rate and biomass) appear to be associated with initial stages of flooding. Annual production/biomass ratios (37-85) are the highest reported for black fly populations. The variation of annual P/B ratios among sites was more strongly dependent on the temporal distribution of standing stock biomass than on differences in growth rates. Variation in production among sites appears to be due to differences in current velocity, hydrograph variability, and abundance of coexisting consumers. (Author's abstract)  
W91-01346

**STONEFLY PREDATION ALONG A HYDRAULIC GRADIENT: A FIELD TEST OF THE HARSH-BENIGN HYPOTHESIS.**  
Cornell Univ., Ithaca, NY. Dept. of Entomology.  
B. L. Peckarsky, S. C. Horn, and B. Statzner.  
Freshwater Biology FWBLAB, Vol. 24, No. 1, p 181-191, August 1990. 5 fig, 3 tab, 39 ref. NSF Grant BSR86-04921.

Descriptors: \*Aquatic insects, \*Environmental gradient, \*Germany, \*Predation, \*Stoneflies, \*Stream ecology, \*Black Forest, \*Environmental effects, \*Hydraulic regime, \*Mayflies, \*Midges, \*Population dynamics.

Microhabitat preferences of predatory stoneflies and four prey taxa were assessed by taking benthic samples along a hydraulic gradient in a Black Forest stream in West Germany. Densities of pred-

ator and prey species were estimated at twenty-one hydraulic regimes. Enclosures containing the stonefly, *Dinocras cephalotes*, and control cages with no predators were placed in the substrate at hydraulic regimes favorable and unfavorable to predators. Cages received initial prey communities that were obtained from benthic samples taken at hydraulic regimes matching those intended for each cage. Population densities of the two most numerically important prey taxa, the mayfly, *Baetis rhodani*, and the Chironomidae, were reduced in the presence of *Dinocras*, but only when enclosures were placed in the hydraulic regimes favorable to the predator. Thus, predation effects increased as the hydraulic regime became more benign to the predators. Densities of two other prey species rare in the diets of *Dinocras* (*Hydropsyche instabilis* and *Gammarus fossarum*) were generally unaffected by predators regardless of the hydraulic regime. These data provide support for the hypothesis that perception of the abiotic regime as harsh or benign to predators is a good predictor of predator impact in densities of preferred prey species. In harsher abiotic regimes, impact will be low, while impact will be high in benign abiotic regimes. (Author's abstract)

W91-01347

#### MOST DILUTE LAKE IN THE WORLD.

E and S Environmental Chemistry, Inc., Corvallis, OR.

J. M. Eilers, T. J. Sullivan, and K. C. Hurley. *Hydrobiologia HYDRB8*, Vol. 199, No. 1, p. 1-6, July 17, 1990. 3 tab, 25 ref. EPA contract No. 69-03-3246.

Descriptors: \*Acid rain, \*Chemistry of precipitation, \*Conductivity, \*Limnology, \*Oligotrophic lakes, \*Oregon, \*Weathering, Base cations, Cascade Mountains, Dilute lakes, Lake Notasha, Monitoring.

Lake Notasha, near the crest of the Oregon Cascade mountain range, is the most dilute lake known. The measured conductivity during two visits was 1.3 and 1.6 microS/cm, with a sum of base cations of 9 and 18 microeq/L; bicarbonate was the dominant anion. Most of the cations in the lake can be accounted for by evapoconcentration of precipitation, although input of weathering products cannot be excluded as a source. The topographic watershed has a mixed coniferous forest, but the physical setting of the lake apparently minimizes hydrologic and ionic contributions from the watershed. This makes lakes such as Notasha appropriate receptors for monitoring acidic and other atmospheric contaminants. (Author's abstract)

W91-01348

#### ASSOCIATIONS OF AQUATIC INSECTS (EPHEMEROPTERA, PLECOPTERA, AND TRICHOPTERA) IN A NETWORK OF SUBARCTIC LAKES AND STREAMS IN QUEBEC.

Montreal Univ. (Quebec). Dept. of Biological Sciences.

P. P. Harper. *Hydrobiologia HYDRB8*, Vol. 199, No. 1, p. 43-64, July 17, 1990. 5 fig, 5 tab, 35 ref.

Descriptors: \*Aquatic insects, \*Caddisflies, \*Lake ecology, \*Limnology, \*Mayflies, \*Quebec, \*Stoneflies, \*Stream ecology, Canada, Environmental impact, Habitats, Hydroelectric power, Monitoring, Seasonal variation, Species diversity, Succession.

As part of an impact assessment of large hydroelectric projects in the James Bay drainage in Northwestern Quebec, the aquatic insect communities were studied in a network of rivers, lakes and streams during the summer of 1975. Thirty-eight emergence traps operated over the ice-free season yielded 10,888 insects (5,509 Ephemeroptera, 2,817 Plecoptera, and 2,512 Trichoptera), representing 148 species (respectively 44, 18, and 86), most of temperate and boreal affinities. There was no arctic element. Similarity analyses and clustering procedures on the emergence series revealed the existence of distinct insect communities in the river (fast and slow sections), the streams (fast and

slow), the lakes and the bogs; each characterized by a particular assemblage of species. Many of the species were more or less ubiquitous and differences between communities were marked more by changes in the dominance of the species and differences in the frequency distributions, than absolute shifts in the species lists. The yields in the traps set in fast water were much greater than those in slow running water, and these in turn greater than those of standing water. By comparison with more southerly sites, the seasonal succession of species was retarded in the spring and early summer, but was not shortened appreciably in the fall. The usual emergence patterns associated with these taxa was observed, namely those of spring, summer and autumn species. (Author's abstract)

W91-01349

#### OCCURRENCE OF LIMNIC MICRO-CRUSTACEANS IN RELATION TO PH AND HUMIC CONTENT IN SWEDISH WATER BODIES.

Uppsala Univ. (Sweden). Limnologiska Institutionen.

B. Berzins, and J. Bertilsson. *Hydrobiologia HYDRB8*, Vol. 199, No. 1, p. 65-71, July 17, 1990. 5 fig, 13 ref.

Descriptors: \*Acid rain effects, \*Crustaceans, \*Data collections, \*Humic acids, \*Hydrogen ion concentration, \*Plankton, \*Sweden, Correlation analysis, Data interpretation, Rotifers, Species distribution, Waterflea.

A large quantity of planktonic and semiplanktonic microcrustacean data collected from a variety of waters in south and central Sweden was computerized. The more frequent species were listed according to pH and humic acid (measured by color as Pt/L) preference. Species indicative of oligotrophic conditions were most abundant just below the neutral pH point (5.5), eurytopic species at a similarly neutral pH, and the eutrophic species *Daphnia cucullata* and *D. magna* were positively correlated with higher pH levels (8.0). No extreme pH preferences were observed. No correlation was found between humic acid and trophic level. In most cases planktonic species occurred at lower humic acid levels and semiplanktonic species at higher levels. Rotifers were distributed over the widest pH range. (White-Reimer-PTT)

W91-01350

#### COMPARISON OF HISTORICAL AND RECENT DATA ON HYDROCHEMISTRY AND PHYTOPLANKTON IN THE RIJNLAND AREA (THE NETHERLANDS).

Hoogheemraadschap van Rijnland, Leiden (Netherlands).

For primary bibliographic entry see Field 5B.

W91-01352

#### CULTURAL EUTROPHICATION OF WEST POINT LAKE—A 10-YEAR STUDY.

Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.

For primary bibliographic entry see Field 5C.

W91-01354

#### ACCUMULATION OF SCANDIUM IN THE SHOOTS OF AQUATIC BRYOPHYTES IN ACID WATER.

National Inst. for Environmental Studies, Ibaraki (Japan).

K. Satke, and M. Nishikawa. *Hydrobiologia HYDRB8*, Vol. 199, No. 3, p. 173-177, July 31, 1990. 1 fig, 2 tab, 17 ref.

Descriptors: \*Acidic water, \*Aluminum, \*Aquatic plants, \*Bioaccumulation, \*Bioindicators, \*Bryophytes, \*Scandium, \*Trace metals, Chile, England, Hydrogen ion concentration, Inductively coupled plasma, Japan, New Caledonia, Solubility.

The content of scandium (Sc) was determined using inductively coupled plasma in the shoots of eighteen species of aquatic bryophytes collected from thirty-five freshwater sites (rivers, streams, lakes, and springs) located in Chile, England, Japan, and New Caledonia. The shoots of aquatic

bryophytes were found to accumulate scandium in acid water, attaining a level of 33 microg/g in *Scapania undulata* in an acid stream with a pH of about 4.2. The content of scandium was highly correlated with that of aluminum in the shoots of *S. undulata* ( $r=0.986$ ,  $0.967$ ;  $p<0.01$ ). The increase in Sc and Al in the basal shoot corresponded to the time of contact with the stream water. Little is known about the behavior of Sc in natural fresh water, but it is recognized that the value of the acid-base equilibrium coefficient of the aquo-scandium ion in water is similar to that of the aquo-aluminum ion which has a higher solubility in acid water than in non-acid water. The results demonstrated the accumulation of Sc by *S. undulata* and *Jungmannia vulcanicola* in acid water. However, the details of Sc accumulation by other aquatic bryophytes and the differences between the accumulation of Sc and Al in acid waters were not apparent. (White-Reimer-PTT)

W91-01355

#### SEASONAL CHANGES IN THE DISSOLVED FREE AMINO ACID AND DOC CONCENTRATIONS IN A HYPERTROPHIC AFRICAN RESERVOIR AND ITS INFLOWING RIVERS.

Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.

R. D. Roberts, R. J. Wicks, and R. Gehr. *Hydrobiologia HYDRB8*, Vol. 199, No. 3, p. 201-216, July 31, 1990. 8 fig, 3 tab, 35 ref.

Descriptors: \*Amino acids, \*Dissolved organic carbon, \*Eutrophication, \*Reservoirs, \*South Africa, Aquatic bacteria, Correlation analysis, Depth, Flow, Influent streams, Rivers, Seasonal variation.

While dissolved free amino acids (DFAA) in marine and fresh waters typically make up only a minor portion (0.1 to 0.5%) of the total pool of dissolved organic carbon (DOC), free amino acids can be important intermediaries in the flux of carbon in lakes. DFAA concentration and composition and DOC concentration were measured over 16 months at three depths in hypertrophic Hartbeespoort Dam, South Africa and its two perennially inflowing rivers. The range of DFAA concentrations in the reservoir and both rivers were similar with dominant DFAA consisting of serine, glycine, alanine and ornithine in all three systems. The range of DOC concentrations in the rivers was 1.5-11.1 mg/L, the major river (Crocodile) had about twice the DOC concentration of the Magalies River. The DFAA/DOC ratios ranged between 0.02-1.1% in the Crocodile River and 0.13-3.7% in the Magalies River. DFAA and DOC concentrations were positively correlated to the Magalies River flow, but for the Crocodile River, which received domestic and industrial effluents, DOC was inversely correlated to flow. The source of DFAA in both rivers was mainly terrestrial, in contrast to the main DOC source in the Crocodile River which was the effluents. The DFAA load of the Crocodile River ranged between 0.22 and 208 kg C/d. DOC (5.0-24.8 mg/L) in Hartbeespoort Dam generally decreased with depth but DFAA (15-4800 nmol/L) concentration showed no clear trend. The DFAA/DOC ratios varied between 0.02 and 2.9%. DFAA concentrations were correlated with bacterial numbers at 0 and 10 m only, while no significant correlations were found with bacterial production at any depth. The rate of bacterial utilization of DFAA was low compared with data from other lakes. Diurnal phytoplankton production of DFAA in the euphotic zone of the whole lake was calculated to vary between 268 and 30,780 t C/d indicating autochthonous DFAA sources were dominant to allochthonous DFAA sources. The autochthonous production of DFAA was  $>2 \times$  gross bacterial production of the euphotic zone indicating that although DFAA concentrations were frequently  $<10$  microg C/L, the rate of DFAA production exceeded bacterial requirements. (Author's abstract)

W91-01356

#### EFFECT OF HYDROPOWER PEAKING FLOW FLUCTUATIONS ON COMMUNITY STRUCTURE AND FEEDING GUILDS OF INVERTE-

## Field 2—WATER CYCLE

### Group 2H—Lakes

**BRATES COLONIZING ARTIFICIAL SUBSTRATES IN A LARGE IMPOUNDED RIVER.**  
Minnesota Univ., St. Paul. Dept. of Forest Resources.  
For primary bibliographic entry see Field 4C.  
W91-01357

**SURVIVAL OF EARLY LIFE STAGES OF BROWN TROUT (SALMO TRUTTA L.) IN RELATION TO ALUMINIUM SPECIATION IN UPLAND WELSH STREAMS.**  
University Coll., Cardiff (Wales). School of Pure and Applied Biology.  
For primary bibliographic entry see Field 5C.  
W91-01362

**MOLLUSCIDAL AND PISCICIDAL PROPERTIES OF COPPER(II) TETRAOXOSULFATE(VI) ON BULINUS GLOBOBUS (MORELET) AND CLARIAS ANGUILLARIS (L.).**  
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Biological Sciences.  
For primary bibliographic entry see Field 5C.  
W91-01363

**STRUCTURE-TOXICITY RELATIONSHIPS FOR SELECTED WEAK ACID RESPIRATORY UNCOUPLERS.**  
Tennessee Univ., Knoxville. Coll. of Veterinary Medicine.  
For primary bibliographic entry see Field 5C.  
W91-01364

**EFFECT OF CADMIUM ON VITELLOGENIN METABOLISM IN ESTRADIOL-INDUCED FLOUNDER (PLATICHTHYS FLEUS (L.)) MALES AND FEMALES.**  
Odense Univ. (Denmark). Biological Inst.  
For primary bibliographic entry see Field 5C.  
W91-01365

**METABOLIC RESPONSE OF GRASS SHRIMP PALAEMONETES KADIKENSI RATHBUN, TO ACUTE EXPOSURE OF SUBLETHAL CHANGES IN PH.**  
Texas A and M Univ., College Station. Dept. of Biology.  
For primary bibliographic entry see Field 5C.  
W91-01366

**EFFECTS OF SUBLETHAL EXPOSURE TO CHLORINE ON THE UPTAKE OF POLYCHLORINATED BIPHENYL CONGENERS BY RAINBOW TROUT, SALMO GAIARDNERI (RICHARDSON).**  
Tennessee Univ., Knoxville. Graduate Program in Ecology.  
For primary bibliographic entry see Field 5C.  
W91-01367

**PHYTOPLANKTON DYNAMICS IN THREE ROCKY MOUNTAIN LAKES, COLORADO, U.S.A.**  
Geological Survey, Denver, CO.  
For primary bibliographic entry see Field 5C.  
W91-01368

**RELATIONSHIPS AMONG DEPTH TO FROZEN SOIL, SOIL WETNESS, AND VEGETATION TYPE AND BIOMASS IN TUNDRA NEAR BETHEL, ALASKA, U.S.A.**  
Gettysburg Coll., PA. Dept. of Biology.  
For primary bibliographic entry see Field 5C.  
W91-01369

**BIOSSEDIMENTOLOGY AND PALEOHYDROLOGY OF HOLOCENE STROMATOLITES FROM LAKE TANGANYIKA (BIOSSEDIMENTOLOGIE DES STROMATOLITES HOLOCÈNES DU LAC TANGANYIKA (BURUNDI). IMPLICATIONS HYDROLOGIQUES).**  
Quebec Univ., Montreal. Centre Geochimie Isotopique et Geochronologie.

For primary bibliographic entry see Field 2J.  
W91-01372

**ECOLOGICAL RELATIONSHIPS OF WILD RICE, ZIZANIA AQUATICA, 9. PRODUCTION IN ORGANIC-FLOCCULENT SEDIMENTS.**  
Lakehead Univ., Thunder Bay (Ontario). Dept. of Biology.  
W. R. Day, and P. F. Lee.  
Canadian Journal of Botany CJBOAW, Vol. 68, No. 7, p 1542-1548, July 1990. 6 fig, 2 tab, 19 ref.

Descriptors: \*Ecosystems, \*Limnology, \*Organic matter, \*Tag Lake, \*Wild rice, Beaver Lake, Collins Lake, Comparison studies, No-Name Lake, Ontario.

Seasonal chemical trends and wild rice production were examined in unproductive organic-flocculent sediments from three lakes: Collins Lake, No-Name Lake, and Tag Lake, Ontario. Variations occurred in the level of organic matter and nutrient concentrations among these lakes. However, these among-lake variations were not as distinct as the differences that occurred between these lakes and a productive wild rice lake, Beaver Lake. Cluster analysis shows the interrelationships of the sediment variables in the three flocculent lakes. The sharpest change in the similarity index occurred after a value of 5, at which point five separate clusters could be defined: cluster 1, pH, P; cluster 2, BD, Fe; cluster 3, Zn, Cu; cluster 4, N, Ca; cluster 5, Mn, K, LOI, and Mg. The variation in the nutrient content between Beaver and the organic-flocculent lakes may reflect the origin of the organic material present in the two types of sediments. Detrital material within sediments acts as a source of nutrients that increase with microbial decomposition, adsorption, deposition, and mineralization of organic matter. Much of the organic matter within organic-flocculent sediments is believed to be peat detritus derived from the surrounding peat bogs and may be classified as sedimentary peat. Sediments derived from peats tend to be resistant to decay and have low bacterial and nutrient content. Macrophytes, algae, and straw, on the other hand, decompose at a faster rate than peat, are likely the major source of sediment in Beaver Lake, and result in the generally higher nutrient levels present in the lake. Nitrogen concentrations were lower in Beaver sediments, but these were likely the result of cumulative nutrient depletion caused by years of wild rice cropping. Sediment density may also affect the release of nutrients from the sediments and accounts for some of the variations between the two types of sediment. (Lantz-PTT)  
W91-01373

**WETLAND IDENTIFICATION: A MEANS TO PREVENT POTENTIAL PUBLIC HEALTH PROBLEMS.**  
Enviram Environmental Consultants, Middlesex, NJ.  
A. V. Agovino.  
Journal of Environmental Health JEVHAH, Vol. 52, No. 5, p 280-281, March/April 1990. 14 ref.

Descriptors: \*Classification, \*Environmental protection, \*Public health, \*Water pollution control, \*Wetlands, Hydrologic properties, Soil properties, Vegetation.

Development pressures across the nation, especially in the Northeast, have focused public attention on the protection and preservation of wetlands. Encroachment upon wetlands threatens a valuable natural resource, while the installation of on-site sewage disposal systems in soils with certain hydric characteristics may adversely affect public health. Although most health departments are not responsible for enforcing regulations related to wetlands, an understanding of wetlands and their characteristics will help the sanitarian or environmental health specialist, who is reviewing site development applications, to anticipate and eliminate potential problems before they occur. Wetlands are the most productive of habitats and are one of the most rapidly disappearing, with thousands of acres lost annually to filling related to development. Wetlands may be delineated using the multi-param-

eter approach employed by the Army Corps of Engineers and other federal agencies. This method requires that the following three parameters be assessed at individual points along the wetland/upland boundary: (1) vegetation; (2) soil; and (3) hydrology. The sanitarian who has knowledge and experience in soils and site evaluation can become a vital part of the growing effort to protect these ecosystems and can concurrently assist in the provision of safe treatment and disposal of sewage through proper siting of the septic systems. (Lantz-PTT)  
W91-01380

**COLONIZATION PROCESS OF A TYPICAL EPILITHIC ALGAL COMMUNITY-HOMOEOTHRIX JANTHINA-ACHNANTHES JAPONICA COMMUNITY-IN A LESS POLLUTED RIVER IN JAPAN (IN JAPANESE).**  
S. Tanaka, and T. Watanabe.  
Japanese Journal of Phycology JJPHDP, Vol. 38, No. 2, p 167-177, June 20, 1990. 8 fig, 14 ref. English summary.

Descriptors: \*Algae, \*Cyanophyta, \*Diatoms, \*Japan, \*Species composition, Ecosystems, Flow pattern, Model studies, Seasonal variation.

The Homoeothrix janthina (blue-green alga)-Achnanthes japonica (diatom) community is a typical epilithic algal community in less polluted rivers in Japan in all seasons except winter. The community development process was studied using substrates placed on the river bed of the River Takami. The study was conducted during the autumn and winter seasons and the transition between the two seasons in order to determine the effects of different water currents. The data indicated that the increase of Achnanthes japonica was caused by the decrease in water velocity near the surface of the substrate on which many trichomes of Homoeothrix janthina grew. A colonization model was also used to explain the change in dominant species and community structure. The model results indicated that the colonization of periphyton in less polluted rivers developed from a two-dimensional structure consisting of diatoms belonging to the prostrate type, sliding type, and upright type to a three-dimensional structure with both diatoms and blue-green algae. (Author's abstract)  
W91-01383

**RELATIONS BETWEEN BROOK TROUT STANDING STOCKS AND HABITAT FEATURES IN BEAVER PONDS IN SOUTHEASTERN WYOMING.**  
Wyoming Cooperative Fishery and Wildlife Research Unit, Laramie.  
For primary bibliographic entry see Field 8I.  
W91-01387

**POTENTIAL CHANGES IN THERMAL STRUCTURE AND CYCLE OF LAKE MICHIGAN DUE TO GLOBAL WARMING.**  
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.  
M. J. McCormick.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 183-194, March 1990. 6 fig, 2 tab, 24 ref.

Descriptors: \*Climatic changes, \*Climatology, \*Global warming, \*Lake Michigan, \*Limnology, \*Model studies, \*Temperature effects, Circulation patterns, Mixing, Seasonal variation, Sensitivity analysis, Stratification, Thermocline, Wind velocity.

A one-dimensional numerical model was used to estimate the present and possible future temperature structures in Lake Michigan. The estimates were based on model output from simulations of the 1981-1984 offshore temperature field. Three scenarios based on general circulation models in which atmospheric CO<sub>2</sub> was doubled were used. The models were those of the Goddard Institute for Space Studies (GISS), the Geophysical Fluid Dynamics Laboratory (GJDL), and the Oregon

State University (OSU). In general, simulations based on these three scenarios suggested that winter and summer heat contents of the lake would be higher than at present; the summer increase would be less than that in winter. The higher winter heat content would cause an earlier onset of full thermal stratification, and the season of stratification would increase by up to two months. The earlier onset of stratification, coupled with little change in the wind stress pattern, would yield stronger stratification and less energy for large-scale vertical mixing. The GISS and GFDL scenarios suggest that the lake may not fully turn over in most winters, so a permanent thermocline may form in the deeper regions of Lake Michigan, below the shallow seasonal thermocline. Should future wind speeds be reduced from those used in the study, sensitivity analyses suggest that the true effect on the annual thermal cycle and structure may be underestimated. Furthermore, given all of the uncertainties surrounding estimates of future climate, these results are best viewed as a sensitivity study, wherein the scales selected for the sensitivity tests are based on the different circulation model scenarios. (Author's abstract)

W91-01389

#### THERMAL STRUCTURE OF THE LOWER GREAT LAKES IN A WARM YEAR: IMPLICATIONS FOR THE OCCURRENCE OF HYPOLIMNION ANOXIA.

National Water Research Inst., Burlington (Ontario).

W. M. Schertzer, and A. M. Sawchuk.

Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 195-209, March 1990. 11 fig, 1 tab, 46 ref.

Descriptors: \*Anoxic conditions, \*Climatology, \*Global warming, \*Great Lakes, \*Hypolimnion, \*Limnology, \*Temperature effects, \*Thermal stratification, Heat flux, Seasonal variation, Thermocline.

Surface heat flux, thermal structure and dissolved oxygen concentrations for the lower Great Lakes were examined for an anomalously warm year, 1983. The year was characterized by large reductions in surface heat losses in winter and above-average surface heat flux gains in summer. On an annual basis, the lakes buffered large surface heat gains in summer months through losses in other months. Observations indicated higher surface water temperatures, significant reductions in duration and extent of ice cover, and an earlier disappearance of the 4°C isotherm, signalling an earlier start to thermal stratification. In response to greater surface heating and low wind conditions, the thermocline formed higher in the water column, and stratification lasted longer than in other years. These conditions contributed to slight hypolimnetic anoxia in the central basin of Lake Erie in the latter half of September. A changed duration and distribution of thermal stratification during warm years has important consequences for water quality issues such as development of hypolimnetic anoxia. Based on conditions in 1983, anoxia may still occur in a warmer climate and factors such as duration of stratification, in addition to thermocline position, may become increasingly important for assessments of anoxia in susceptible lakes. (White-Reimer-PTT)

W91-01390

#### EFFECTS OF CLIMATE WARMING ON DISSOLVED OXYGEN CONCENTRATIONS IN LAKE ERIE.

HydroQual, Inc., Mahwah, NJ.

A. F. Blumberg, and D. M. Di Toro.

Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 210-223, March 1990. 9 fig, 2 tab, 33 ref. EPA Contract 68-01-7288.

Descriptors: \*Climatic changes, \*Climatology, \*Dissolved oxygen, \*Global warming, \*Lake Erie, \*Limnology, \*Model studies, \*Temperature effects, \*Anoxic conditions, Great Lakes, Mass balance, Stratification, Thermocline, Water circulation, Water quality.

A coupled hydrodynamic and water quality model was used to examine the response of dissolved

oxygen concentrations to warming of the central basin of Lake Erie. An area-averaged hydrodynamic model was used to estimate the lake temperatures and thermocline variability as forced by surface heating and winds. Vertical turbulence mixing processes were incorporated by a second-moment, turbulence closure submodel. The water quality model comprised a set of 15 mass balance equations that predicted distributions of phytoplankton biomass, nutrient concentration, and dissolved oxygen. A synthesis of the results from the coupled model forced by climate warming scenarios from three atmospheric general circulation models suggested that there will be a substantial decline in oxygen concentrations in the central basin. Although forecasts of future conditions that are beyond established experiences are uncertain, it appears likely that climate warming will lead to such a decline regardless of details in changes of lake stratification dynamics. Losses of 1 mg/L of dissolved oxygen in the upper layers and of 1-2 mg/L in the lower layers of Lake Erie's central basin can be expected, along with an increase in the area of the lake that is anoxic. The decline in dissolved oxygen is predicted to be due to warmer lake temperatures, which increase the rate of bacterial activity in the hypolimnion waters and sediment, rather than to thermocline location and volume of water below the thermocline. (Author's abstract)

W91-01391

#### TEMPERATURE-OXYGEN HABITAT FOR FRESHWATER AND COASTAL STRIPED BASS IN A CHANGING CLIMATE.

Oak Ridge National Lab., TN. Environmental Sciences Div.

For primary bibliographic entry see Field 2B.

W91-01393

#### POTENTIAL CHANGES IN THE THERMAL HABITAT OF GREAT LAKES FISH AFTER GLOBAL CLIMATE WARMING.

Wisconsin Univ.-Madison. Center for Limnology. For primary bibliographic entry see Field 2B.

W91-01394

#### POTENTIAL EFFECTS OF GLOBAL CLIMATE WARMING ON THE GROWTH AND PREY CONSUMPTION OF GREAT LAKES FISH.

Wisconsin Univ.-Madison. Center for Limnology. For primary bibliographic entry see Field 2B.

W91-01395

#### EFFECT OF AIR TEMPERATURE ON GROWTH OF LARGEMOUTH BASS IN NORTH AMERICA.

Wilfrid Laurier Univ., Waterloo (Ontario). Dept. of Biology.

R. W. McCauley, and D. M. Kilgour.

Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 276-281, March 1990. 4 fig, 21 ref, append.

Descriptors: \*Air temperature, \*Black bass, \*Fish populations, \*Global warming, \*North America, \*Temperature effects, \*Climates, Climatic data, Correlation analysis, Distribution, Growth, Model studies, Thermal effects.

The relationship between air temperature and growth for geographically disparate populations of largemouth bass *Micropterus salmoides* were examined by using published data in conjunction with climatological records. The thermal component of climate best correlated with growth was accumulated day-degrees over 10°C. This measure of climate was suggested by a simple model in which growth rate is proportional to temperature in excess of 10°C. Correlations (0.79-0.84) between total mean lengths each year (years 3-8) and accumulated day-degrees were significant, and indicated that more than half the variability in growth may be attributed to environmental temperature. Theoretical growth curves reconstructed from these regression lines agreed well with those observed for natural populations. In addition to affecting growth rates, climate warming will extend the ranges of warmwater species northward. It has

been suggested that the 18°C July isotherm may delineate the northern boundary of the range of several species, including largemouth bass. (Author's abstract)

W91-01396

#### SEA LAMPREY AS AN EARLY RESPONDER TO CLIMATE CHANGE IN THE GREAT LAKES BASIN.

Toronto Univ. (Ontario). Dept. of Zoology.

For primary bibliographic entry see Field 2B.

W91-01398

#### SIZE-DEPENDENT WINTER MORTALITY OF YOUNG-OF-THE-YEAR WHITE PERCH: CLIMATE WARMING AND INVASION OF THE LAURENTIAN GREAT LAKES.

York Univ., Toronto (Ontario). Dept. of Biology.

For primary bibliographic entry see Field 8I.

W91-01399

#### CLIMATE, POPULATION VIABILITY, AND THE ZOOGEOGRAPHY OF TEMPERATE FISHES.

Ontario Ministry of Natural Resources, Maple. Fisheries Branch.

For primary bibliographic entry see Field 2B.

W91-01400

#### INFLUENCE OF TEMPERATURE CHANGES ON AQUATIC ECOSYSTEMS: AN INTERPRETATION OF EMPIRICAL DATA.

Toronto Univ. (Ontario). Dept. of Zoology.

For primary bibliographic entry see Field 2B.

W91-01403

#### GAS TRANSFER VELOCITIES IN LAKES MEASURED WITH SF<sub>6</sub>.

University of East Anglia, Norwich (England). School of Environmental Sciences.

R. C. Upstill-Goddard, A. J. Watson, P. S. Liss, and M. I. Liddocost.

Tellus TELLAL, Vol. 42B, No. 4, p 364-377, September 1990. 8 fig, 2 tab, 49 ref.

Descriptors: \*Air-water interfaces, \*England, \*Gas transfer velocity, \*Lakes, \*Limnology, \*Wind velocity, Data interpretation, Physical properties, Water circulation, Wind, Wind-driven currents.

The experimentally-determined relationships between air-water gas transfer velocity and wind-speed were examined for two small, rapidly mixed lakes in upland southwest England. High-precision estimates of the gas transfer velocity with daily resolution, were derived by monitoring the rate of evasion from the lakes of added sulfur hexafluoride, SF<sub>6</sub>, an inert, sparingly soluble, man-made gaseous tracer. Corresponding data on in situ wind speeds and directions, and surface water temperatures were automatically logged as a time series of 4 minute averages, using a battery-powered device. The results significantly extend the existing field database and show a strong dependence of gas transfer velocity, normalized to CO<sub>2</sub> at 20°C, on windspeed in the range of about 2-13 m/second, corrected to a height of 10 m. No correlation was found between gas transfer velocity and wind direction. The data are fitted with two least-squares straight lines which intersect at a windspeed of 9.5 ± 0.3 m/second, beyond which significant steepening of the gas transfer velocity versus windspeed relationship implies a transition from the rough surface to breaking wave regime. This finding is in broad agreement with previous conclusions. Nevertheless, the data scatter about the fitted lines exceeds that which would be predicted from the associated analytical uncertainties. This implies the observed relationships between gas transfer velocities and windspeed are not unique, and therefore, that additional factors must be important in determining gas transfer velocities. (Author's abstract)

W91-01412

## Field 2—WATER CYCLE

### Group 2H—Lakes

**PREDICTION OF PHOSPHATE COPRECIPITATION WITH CALCITE IN FRESHWATERS.**  
Freshwater Biological Association, Wareham (England). River Lab.  
W. A. House.

Water Research WATRAG, Vol. 24, No. 8, p 1017-1023, August 1990. 3 fig, 3 tab, 29 ref.

**Descriptors:** \*Calcite, \*Chemical properties, \*Lakes, \*Limnology, \*Nutrients, \*Phosphates, \*Precipitation, Chemical interactions, Chemical reactions, Coprecipitation, Epilimnion, Hydrogen ion concentration.

In lakes the coprecipitation of phosphorus is an important self-cleaning mechanism and can result in the removal of as much as 97% of the phosphorus from the epilimnion. It is estimated that about 35% of the total phosphorus removal from the epilimnion of a lake could be coprecipitated with calcite. The coprecipitation reaction is caused by the interaction between inorganic phosphorus and the calcite surface during crystal growth, followed by the incorporation of some of the surface phosphorus into the bulk structure as growth occurs. The application of a model to describe inorganic phosphate coprecipitation with calcite in freshwaters was investigated. An approximate form of the coprecipitation equation was developed and tested using data from studies of the coprecipitation kinetics in different river waters. The results indicate that within certain pH limits and phosphate concentration, the simplified equation describes the adsorption function and hence coprecipitation behavior reasonably well (within 10% of the value obtained using the full form of the coprecipitation equation). When the adsorption function is not significantly changed during the coprecipitation reaction, the phosphate coprecipitation rate is linearly related to the calcite precipitation rate. (Mertz-PTT)

W91-01423

**SEASONAL AND LONG-TERM TRENDS IN TRUCKEE RIVER NUTRIENT CONCENTRATIONS AND TRUCKEE RIVER NUTRIENT CONCENTRATIONS AND LOADINGS TO PYRAMID LAKE, NEVADA: A TERMINAL SALINE LAKE.**

Fish and Wildlife Service, Columbia, MO.  
For primary bibliographic entry see Field 5B.  
W91-01425

**GEOGRAPHICAL DISTRIBUTION OF CONTAMINANTS AND PRODUCTIVITY MEASURES OF HERRING GULLS IN THE GREAT LAKES: LAKE ERIE AND CONNECTING CHANNELS 1978/79.**

Canadian Wildlife Service, Burlington (Ontario), Ontario Region.  
For primary bibliographic entry see Field 5B.  
W91-01454

**ENVIRONMENTAL IMPACTS OF DEVELOPMENT ON WETLANDS IN ARID AND SEMI-ARID LANDS.**

University Coll., London (England). Dept. of Geography.  
For primary bibliographic entry see Field 6G.  
W91-01462

**REAL-TIME MULTIPURPOSE RESERVOIR OPERATION: A CASE STUDY.**

Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 4A.  
W91-01464

**PIRLA PROJECT (PALEOECOLOGICAL INVESTIGATION OF RECENT LAKE ACIDIFICATION): AN INTRODUCTION TO THE SYNTHESIS OF THE PROJECT.**

Indiana Univ. at Bloomington. Dept. of Biology.  
For primary bibliographic entry see Field 5B.  
W91-01498

**PALEOECOLOGICAL INVESTIGATION OF RECENT LAKE ACIDIFICATION IN THE ADIRONDACK MOUNTAINS, N.Y.**

Indiana Univ. at Bloomington. Dept. of Biology.  
For primary bibliographic entry see Field 5B.  
W91-01499

**SEQUENTIALLY EXTRACTED METALS IN ADIRONDACK LAKE SEDIMENT CORES.**

Indiana Univ., Bloomington. School of Public and Environmental Affairs.  
J. R. White, and C. P. Gubala.  
Journal of Paleolimnology JOUPE8, Vol. 3, No. 3, p 243-252, 1990. 3 fig, 2 tab, 33 ref. Electric Power Research Institute fund RP-2174-10.

**Descriptors:** \*Acid rain effects, \*Adirondack Mountains, \*Cores, \*Lake sediments, \*Limnology, \*Metals, \*New York, \*Paleolimnology, \*Sediment chemistry, Acid lakes, Aluminum, Biochemistry, Deposition, Diatoms, Geochemical cycles, Iron, Lead, Manganese, Watersheds, Zinc.

Metal deposition patterns have been examined in sediment cores from three lakes in the Adirondack region of New York as part of the Paleocological Investigation of Recent Lake Acidification (PIRLA) project. Sequential chemical extraction of Al, Fe, Mn, Pb, and Zn has yielded information on their chemical nature and potential mechanisms involved in their deposition. Results indicate historical changes in watershed chemistry may have influenced metal chemistry in these lakes. Detailed descriptions of the chemical forms of metals in sediments is not possible due to the fact that extraction methods are only operational. However, in two systems known to have been acidified in recent time by acidic deposition, concentrations of labile Al increase after 1940-1950, corresponding with lake acidification as inferred from diatom assemblages. Temporal trends in the inputs of Pb in the Cl-C4 fraction are also consistent with known historical changes in atmospheric Pb inputs to the region. Chemical stratigraphies of Fe and Mn are most likely dominated by internal biogeochemical cycling within sediments. (See W91-01498, W91-01499, W91-01501, and W91-01502) (Author's abstract)

W91-01500

**CALCULATION AND UNCERTAINTY ANALYSIS OF Pb-210 DATES FOR PIRLA PROJECT LAKE SEDIMENT CORES.**

Harvard Univ., Cambridge, MA. Dept. of Landscape Architecture.  
M. W. Binford.  
Journal of Paleolimnology JOUPE8, Vol. 3, No. 3, p 253-267, 1990. 5 fig, 3 tab, 24 ref. Electric Power Research Institute fund RP-2174-10.

**Descriptors:** \*Acid rain, \*Error analysis, \*Florida, \*Lake sediments, \*Lead radioisotopes, \*Limnology, \*Paleolimnology, \*Radioactive dating, Acid lakes, Cores, Diatoms, Mathematical models, Metals, Monte Carlo method, Radioactivity, Uncertainty.

Lead-210 assay and dating are subject to several sources of error, including natural variation, the statistical nature of measuring radioactivity, and estimation of the supported fraction. These measurable errors are considered in calculating confidence intervals for Pb-210 dates. Several sources of error, including the effect of blunders or misapplication of the mathematical model, are not included in the quantitative analysis. First-order error analysis and Monte Carlo simulation of cores from Florida Paleocological Investigation of Recent Lake Acidification (PIRLA) project lakes were used as independent estimates of dating uncertainty. It was found that constant-rate-of-supply (CRS) model dates average less than 1% older than Monte Carlo median dates, but the difference increases nonlinearly with age to a maximum of 11% at 160 years. First-order errors increase exponentially with calculated CRS model dates, with the largest 95% confidence interval in the bottom-most datable section being 155 (+ or -) 90 years, and the smallest being 128 (+ or -) 8 years. Monte Carlo intervals also increase exponentially with age, but the largest 95% occurrence interval is 152

(+ or -) 44 years. Confidence intervals calculated by first-order methods and ranges of Monte Carlo dates agree fairly well until the Pb-210 date is about 130 years old. Older dates are unreliable because of this divergence. (See W91-01498 thru W91-01500 and W91-01502) (Author's abstract)

W91-01501

**UTILITY OF SCALED CHRYSOPHYTES FOR INFERRING LAKEWATER PH IN NORTHERN NEW ENGLAND LAKES.**

Queen's Univ., Kingston (Ontario). Dept. of Biology.  
S. S. Dixit, J. P. Smol, D. S. Anderson, and R. B. Davis.

Journal of Paleolimnology JOUPE8, Vol. 3, No. 3, p 269-286, 1990. 7 fig, 6 tab, 74 ref. Electric Power Research Institute fund RP-2170-10; NSF Grant DEB7810641.

**Descriptors:** \*Acid lakes, \*Acid rain effects, \*Chrysophyta, \*Hydrogen ion concentration, \*Lake acidification, \*Limnology, \*New England, \*Paleolimnology, \*Zooplankton, Biological studies, Correlation analysis, Model studies, Sediment analysis, Stratigraphy.

As part of the Paleocological Investigation of Recent Lake Acidification (PIRLA) project, scaled chrysophytes in the surface sediments of 58 soft-water northern New England lakes were analyzed to assess their usefulness for inferring pH. The distributions of many taxa were correlated with lakewater pH and associated variables. Canonical correspondence analysis (CCA) and clustering allowed chrysophyte taxa to be grouped according to their distributions along the pH gradient. For example, Chrysodidymus synuroides, Mallomonas hindoni, and M. hamata commonly occur in acidic water (pH < 5.5), whereas M. caudata and M. pseudocoronata are common in circumneutral to alkaline waters. Of the five predictive models developed to infer pH, CCA-based calibration had the lowest standard error (0.35 pH units). A CCA-based predictive model was also developed to infer total alkalinity. There is strong evidence that, in the absence of past measured pH data, stratigraphic studies of sedimentary chrysophyte scales will provide accurate reconstructions of pH in northern New England lakes. (See W91-01498 thru W91-01501) (Author's abstract)

W91-01502

**ANNUAL STONEFLY (PLECOPTERA) PRODUCTION IN A SECOND ORDER OKLAHOMA OZARK STREAM.**

North Texas State Univ., Denton. Dept. of Biological Sciences.

K. M. Jop, and K. W. Stewart.  
Journal of the North American Benthological Society JNASEC, Vol. 6, No. 1, p 26-34, March 1987. 1 fig, 6 tab, 32 ref. National Science Foundation Grants DEB 78-12565 and BSR 8308422.

**Descriptors:** \*Aquatic insects, \*Oklahoma, \*Secondary productivity, \*Stoneflies, \*Stream biota, \*Stream ecology, Aquatic habitats, Aquatic populations, Biomass, Energy, Organic matter, Particulate matter, Predation.

Knowledge of aquatic insect secondary production is of considerable ecological importance from both population (individual growth and population survivorship) and community (energy flow) perspectives. Total annual production by the stonefly assemblage (13 species in riffles) of a second-order Ozark foothills stream was 6.1/g dry weight or 25.5/g wet weight/sq m. The contribution of individual species to total stonefly production (dry weight) ranged from 0.01/g/sq m for Allocapnia rickeri to 2.57/g/sq m for Acroneuria evoluta. Over 50% of the stonefly production was contributed by the perid predators Acroneuria evoluta and Agnetina capitata. Predators contributed 83% of the total stonefly biomass and 67% of the total production, even though they represented only 22% of the total abundance. Omnivores and shredders, which formed 78% of total stonefly density, contributed only 17% to the total biomass and 33% to total production. Stoneflies from samples

containing 6 g or more combined fine particulate organic matter and coarse particulate organic matter accounted for 67.2% of the total production. The high stonely production of this Ozark foothills stream apparently contributes substantially to its total energy budget. (Author's abstract) W91-01506

# **THERMAL AND TROPHIC STABILITY OF DEEPER MAINE LAKES IN GRANITE WATERSHEDS IMPACTED BY ACID DEPOSITION.**

Maine Univ. at Orono. Dept. of Geological Sciences.

For primary bibliographic entry see Field 5C. W91-01530

# **STUDIES ON THE PHYSICO-CHEMICAL PROPERTIES OF WATER THEIR VARIATION IN THE ERHAI LAKE (IN CHINESE).**

Research Institute of Environmental Protection, Yunnan, China.

B. H. Du.

Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 6, p 538-543, November 1989. 5 fig, 2 tab, 3 ref. English summary.

Descriptors: \*China, \*Er Hai (lake), \*Lakes, \*Limnology, \*Water chemistry, Air temperature, Biological oxygen demand, Chemical oxygen demand, Chemical properties, Dissolved oxygen, Nitrogen, Phosphorus, Seasonal variation, Transparency, Water temperature, Yunnan Plateau, pH.

Lake Erhai is situated at the west end of the Yunnan plateau. Its catchment area is 2565 sq km and the area of the lake is 250 sq km with a mean depth of 10.5 m and a maximum depth of 20.5 m. The pH, DO, BOD<sub>5</sub>, COD, total nitrogen and total phosphorus along with their changes in two-month intervals from April 1985 to April 1986 were measured. In addition, the atmospheric temperature, the water temperature, precipitation, transparency and water level of the lake were also recorded. The variation of these physico-chemical properties was related to seasonal changes in the climate. In June and August, pH, BOD<sub>5</sub>, COD, and total-N are very high, while transparency and DO levels were low. These values are reversed in February, which is the month with the lowest precipitation and the lowest lake level. The average lake water values for this period are: water temperature, 16.9°C; transparency, 3.4 m; pH, 8.54; DO, 7.33 mg/l; BOD<sub>5</sub>, 2.33 mg/l; COD, 2.54 mg/l; total N, 0.605 mg/l; and total P, 0.031 mg/l. (Author's abstract) W91-01568

# **LAKESHORE SWAMPS OF BOSTIENG LAKE IN THE XINJIANG AUTONOMOUS REGION (IN CHINESE).**

Changchun Inst. of Geography (China).

X. H. Ma.

Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 6, p 554-563, November 1989. 5 fig, 7 tab, 5 ref. English summary.

Descriptors: \*Baseline studies, \*Bostien Lake, \*China, \*Flora, \*Limnology, \*Marsh plants, \*Swamps, \*Wetlands, Arid climates, Eutrophication, Kaidu River, Peat, Reeds, Surveys, Typha, Xinjiang, Yangqi Basin.

The lakeshore swamps of Bostien Lake in Xinjiang cover about 400 sq km and make up the largest areal swamp land in the arid zone of China. The climate of this region is temperate and arid. The Kaidu River with an origin in Tianshan Mountain and other creeks discharge a total of 4.16 billion cu m of water annually into the Yangqi basin. This stable water supply is the leading factor in swamp formation. The Yangqi basin is a good place for swamp formation and peat accumulation. The swamp is composed mainly of Typha and other reeds and herbaceous plants with an annual reed production that reaches 22.95 million tons. This provides an abundant raw material resource for the papermaking industry. Peat reserves in the

swamps are nearly a hundred million tons, however peat in this area is unsuitable for large scale exploitation. Bostien Lake and the lakeshore swamps are a special ecosystem under desert climate conditions, which plays an important role in maintaining the regional ecological balance. (Author's abstract) W91-01569

# **ACCUMULATION OF HEAVY METALS AND THE VARIATION OF AMINO ACIDS AND PROTEIN IN EICHHORNIA CRASSIPES (MART.) SOLMS IN THE DIANCHI LAKE (IN CHINESE).**

Academia Sinica, Beijing (China). Research Center for Eco-Environmental Sciences.

For primary bibliographic entry see Field 5B. W91-01572

# **SODA LAKES ON INNER MONGOLIA PLATEAU, CHINA.**

Qinghai Inst. of Salt Lake, Xining (China).

D. F. Sun.

Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 1, p 44-54, January 1990. 4 fig, 6 tab, 6 ref. English summary.

Descriptors: \*China, \*Geochemistry, \*Mongolia, \*Saline lakes, \*Salinity, \*Water chemistry, Arid climates, Badanjiling Basin, Clays, Climates, Eerdusi Basin, Erlan Basin, Geohydrology, Hailar Basin, Hydrogen ion concentration, Minerals, Trona.

The inner Mongolian plateau is one of the most important areas of salt lakes in China with trona deposits known throughout the world. The soda lakes spread mainly over the northern region of the Eerdusi basin, the central Erlan basin, the southeastern Hailar basin and Badanjiling desert. Generally, they cover an area from several to several dozen sq km, and are surrounded by sand dunes. The salinity of soda lake brines is 200-350 g/L, with pH values of 9.09-10.67. The brines mainly consist of Na(+), K(+), Cl(-), SO<sub>4</sub>(-), CO<sub>3</sub>(-) and HCO<sub>3</sub>(-) ions and therefore, belong to the Na-CO<sub>3</sub>-SO<sub>3</sub>-Cl type of brine. These are usually two layers of trona deposits in the soda lakes on the plateau composed mainly of natron, mirabilite, halite, and trona, as well as interbeds of black mud which contains a lot of illite clay, and much less gillussite, dolomite and calcite. The trona layers always occur in a type of 'bull's eye pattern' in various lakes. Commonly, the soda lakes on the plateau were formed on the basin of deflation depressions from the beginning of the early Holocene. However, those trona deposits were precipitated mostly during the low temperatures of the mid-late Holocene. This was proved by laboratory freezing experiments and spore-pollen analysis. (Author's abstract) W91-01574

# **WATER BODY EVAPORATION EXPERIMENT OF POYANG LAKE (IN CHINESE).**

Hydrometeorological Experiment Station of Poyang Lake, Xingzi (China).

Z. X. Yin, and Q. Min.

Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 1, p 70-79, January 1990. 6 fig, 6 tab, 6 ref. English summary.

Descriptors: \*China, \*Lake evaporation, \*Lakes, \*Poyang Hu (lake), Climates, Precipitation, Seasonal variation.

Poyang Lake is the largest fresh water lake in China. A study was conducted to determine the empirical formula and converting coefficients of the evaporation capacity of the surface of the lake, and the spatial change features of evaporation for the water surface as well as the characteristics of the evaporation discharge. The multiannual average evaporation capacity of Poyang Lake is 1163.3 mm. It increases gradually from February to July and decreases from September to December. The annual change is single peaked which is consistent with hydrological and meteorological factors. The annual evaporation capacity changes slightly. A trend was observed indicating that the change of

evaporation capacity in the 1980's was smaller than that in the 1970's, which was smaller than in the 1960's. The distribution of annual evaporation from the surface is in line with the change in wind velocity. The annual evaporation capacity and the change of wind velocity from the surface are greater in the middle of the lake and less near the lake shore. The multiannual average evaporation discharge from the lake is 2.704 billion cubic m, which constitutes 21.5% of the water generation capacity, 11.0% of the lake capacity and 1.8% of the inward flow from the valleys. The evaporation capacity is greater than the water generation capacity from August to October. The supply flowing from the valleys is the key problem which should be taken into account in projects concerned with the control of Poyang Lake. (Author's abstract) W91-01576

# **ANALYSIS OF AIR TEMPERATURE EFFECT OF TAIHU LAKE (IN CHINESE).**

Academia Sinica, Nanjing (China). Inst. of Geography.

H. B. Lu, and G. L. Wei.

Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 1, p 80-87, January 1990. 9 fig, 5 tab, 8 ref. English summary.

Descriptors: \*Air temperature, \*China, \*Lakes, \*Limnology, \*Tai Hu (lake), Changjiang Plain, Climates, Meteorology, Surface area, Temperature effects.

Taihu Lake is a large shallow fresh water lake in the lower Changjiang Plain, China, with an area of 2,428 square km and an average depth of 1.9 m. Its air temperature effects were analyzed with the data obtained from 14 meteorological stations including six stations specially set up in the Taihu Lake area. The profile of maximum air temperature approximated a hyperbola and that of minimum air temperature a parabola in the Taihu lake area. The mean air temperature effect of Taihu Lake was calculated using the data obtained in 1983-1984. The results show that the annual mean air temperature effect was 0.81°C for the lake surface, 0.56°C for the islands, and 0.34°C for the lake shores. The strongest effect appeared in November, reaching 1.79°C, 1.39°C and 0.92°C, while the weakest effect occurred in June, 0.29°C, 0.09°C, and 0.06°C. The annual mean maximum air temperature on the shores was 0.3-1.0°C lower than that on the surrounding meteorological stations far from the lake. The extreme minimum air temperature on the lake surface was 3.0-5.0°C higher than that on the meteorological station which is located NW far from the lake. The impact of prevailing winds on the Taihu Lake air temperature effect were estimated, and the diagrams and empirical formulae for the minimum air temperature in water and the mean minimum air temperature in January on the lake surface are presented. The air temperature effects of Taihu Lake can reduce low temperature disasters for the double rice harvest in the lake region. (Author's abstract) W91-01577

# **RECORD-BREAKING RISE OF GREAT SALT LAKE IN 1981-1986 RELATED TO ANOMALOUS MID-TROPOSPHERIC WIND PATTERNS.**

Scripps Institution of Oceanography, La Jolla, CA. J. Namias.

Wetter und Leben WTLBAR, Vol. 41, No. 1/4, p 85-94, 1989. 8 fig, 6 ref. NSF Grant ATM-8407891, US Nat. Pro. Office Grant NA81AA-D-00054, USGS, Dept. of Interior Award No. 14-08-0001-G1483.

Descriptors: \*Climatology, \*Great Salt Lake, \*Precipitation, \*Water level, \*Weather patterns, Lake level, North America, Seasonal variation, Wind patterns.

The Great Salt Lake has experienced many periods of excessive rainfall leading to high lake levels. The latest and highest of these occurred during the years 1981-1986 when the lake reached an historical level of 1283.77 m. The normal level computed

## Field 2—WATER CYCLE

### Group 2H—Lakes

for a period of 140 years from 1847 on was 1280 m. Increased precipitation, 134% higher than normal, was the principal cause for the rise in lake level. While there was above normal precipitation over much of the year, the fall season (September, October, November) exhibited the greatest increase in precipitation. It was shown that upper level prevailing contour and wind patterns in the mid-troposphere were responsible for these conditions. Anomalous wind systems dominated a large portion of the northern hemisphere indicating that the conditions at Salt Lake were not unique. This analysis suggests that the Salt Lake's levels and precipitation patterns are good indices of total U.S. precipitation. The physical reasons for this lay in the peculiar course of cyclones and their induced vertical motions, and in the siphoning of rich moisture supplies from the eastern North Pacific and the Gulf of Mexico. (King-PTT)  
W91-01580

**MEASUREMENT OF EXOENZYMATIC ACTIVITY IN STREAMBED SEDIMENTS USING METHYLBELLIFERYL-SUBSTRATES.**  
Max-Planck-Inst. fuer Limnologie, Schlitz (Germany, F.R.). Limnologische Flussstation.  
For primary bibliographic entry see Field 2J.  
W91-01587

**METHOD OF MEASURING THE DEHYDROGENASE ACTIVITY OF SEDIMENTS.**  
Sofia Univ. (Bulgaria). Dept. of Ecology.  
For primary bibliographic entry see Field 2J.  
W91-01588

**GROWTH OF BACTERIA ON ORGANIC MATTER PRODUCED BY ALGAE IN CONTINUOUS CULTURES.**  
Ceskoslovenska Akademie Ved, Prague. Hydrobiologicka Lab.  
V. Vyhalek, and K. Simek.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 37-42, 1990. 2 fig, 16 ref.

Descriptors: \*Algae, \*Bacteria, \*Culturing techniques, \*Extracellular metabolism, \*Limnology, \*Organic matter, \*Plankton, Analytical techniques, Bacterial physiology, Biomass, Phytoplankton, Primary productivity.

Quantification of the fluxes of organic material from phytoplankton to bacterioplankton is difficult in natural waters. Biomass of algal cells and accompanying bacteria was quantified in non-axenic steady-state cultures of the green alga *Chlamydomonas reinhardtii*. Bacterial biomass produced in cultures was used to estimate a release of organic matter from algal cells. The inflowing medium was inorganic, no herbivorous zooplankton was present and no mortality of the *Chlamydomonas* cells was found during steady-state conditions. Therefore organic exudates of living algae were assumed to be the sole source of carbon for bacterial growth. In steady-states where *C. reinhardtii* grew under phosphorus limitation, the estimated exudate production (EP) did not exceed 6% of the net primary production. In contrast, in steady-states with light limitation of algal growth, EP ranged from 11.5 to 68.5% of the net primary production of *C. reinhardtii*. Continuous cultures of algae can therefore be used to provide information about the release of organic matter from algal cells and its utilization by bacteria. (Author's abstract)  
W91-01589

**EFFECT OF EXTRACELLULAR ORGANIC CARBON (EOC) FROM PHYTOPLANKTON ON THE COMMUNITY STRUCTURE OF OLIGOTROPHIC BACTERIA.**  
Kyoto Univ. (Japan). Faculty of Agriculture.  
K. Fukami, S. Ohara, and Y. Ishida.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 43-47, 1990. 2 fig, 1 tab, 5 ref.

Descriptors: \*Aquatic bacteria, \*Extracellular metabolism, \*Lakes, \*Limnology, \*Oligotrophy, \*Organic carbon, \*Phytoplankton, \*Species composition, Bacterial analysis, Bacterial physiology, Culture media, Culturing techniques, Japan, Lake Biwa, Oligotrophic bacteria, Seasonal variation.

The effect of phytoplankton, through their extracellular organic carbon (EOC), on the community structure of oligotrophic bacteria was studied. This was done by comparing the most-probable number (MPN) of oligotrophic bacteria, using filtered lake-water samples containing different dominant species of phytoplankton as MPN media. Water samples to be used for the counting of bacterial numbers were collected once a month at a depth of 6 m in the northern part of Lake Biwa, Japan. A part of each sample was sterilized by passage through a Millipore filter with a 0.22-micron pore size. When they were not used immediately, filtered water samples were kept frozen at -20 C until employed for experiments. Artificial peptone medium of low concentration was used as a reference medium. Bacterial MPNs from inocula cultured in water collected at the same time as the inoculum were compared with MPNs for inocula cultured in water collected in other months and for inocula cultured in the reference medium. In most cases, MPNs with simultaneously-collected lake water medium were remarkably higher than those with the other two media. However, MPN values were comparable when MPN media were prepared with lake water of different seasons which contained the same dominant species of phytoplankton as media prepared with simultaneously-collected lake water. Moreover, it was shown that media prepared with the filtrate of an axenic culture of *Staurostrum dorsidentiferum* gave much higher MPN values for bacterial communities that were present during seasons when this phytoplankton species predominated than did even simultaneously-collected lake water media. These results indicate that dominant species of phytoplankton affect, through their extracellular organic carbon, the community structure of oligotrophic bacteria in natural waters. (MacKeen-PTT)  
W91-01590

**CARBON FLUX FROM PHYTOPLANKTON TO FREE-LIVING BACTERIAL DNA.**  
Shinshu Univ., Matsumoto (Japan). School of Allied Medical Sciences.  
K. Kato.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 49-52, 1990. 2 tab, 14 ref. The Ministry of Education, Science and Culture, Japan, Grants 60129034, 61134044 and 62124040.

Descriptors: \*Aquatic bacteria, \*DNA, \*Dissolved organic carbon, \*Eutrophic lakes, \*Limnology, \*Nutrients, \*Phytoplankton, Bacterial DNA, Bacterial analysis, Bacterial physiology, Carbon cycle, Japan, Lake Suwa, Radioactive tracers.

Extracellularly released dissolved organic carbon (EDOC) from photosynthesizing phytoplankton is considered to be an effective source for the growth of bacteria in the euphotic zone of pelagic ecosystems. Measurement of planktonic bacterial DNA synthesis from algal excretion was carried out in a eutrophic lake, Lake Suwa, in spring 1986 using C-14 labeled bicarbonate tracer. The algal biomass ranged from several microg to 30 microg chl a/L. Up to 10% of added C-14 bicarbonate was fixed by planktonic organisms in 4 h, 1.8 to 8.4% of which was found in the free-living bacterial fraction. Direct fixation of C-14 bicarbonate by free-living bacteria amounted to only 13 +/- 5% of the total cellular C-14 fixed into this fraction. Thus, more than 80% of C-14 fixed by free-living bacteria originated from phytoplankton via the dissolved organic phase, EDOC. The transformation constant of C-14 from phytoplankton to free-living bacterial DNA in the study was estimated at 1%. (MacKeen-PTT)  
W91-01591

**ALGAL EXUDATION AND ITS RELATION TO BACTERIAL PRODUCTION DURING VERNAL PHYTOPLANKTON BLOOMS.**  
Tvarminne Zoological Station (Finland).  
R. Lignell.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 53-59, 1990. 1 fig, 1 tab, 22 ref.

Descriptors: \*Algae, \*Algal blooms, \*Aquatic bacteria, \*Bacterial productivity, \*Dissolved solids, \*Extracellular metabolism, \*Phytoplankton, Bacte-

rial physiology, Baltic Sea, Carbon cycle, Dissolved organic carbon, Marine bacteria, Organic compounds, Primary productivity, Radioactive tracers.

In pelagic waters, algal release of dissolved organic photosynthates is a major autochthonous pathway of substrates for bacteria. Phytoplankton primary production and release of extracellular organic compounds (exudation) were compared with measurements of bacterial production during spring bloom periods in the Baltic Sea. Net exudation (dissolved exudate pool) varied between 1 and 7% of the primary productivity. Nutrient enrichment caused a significant decrease in the percentage net exudation (PER) values. On the other hand, the net PER values decreased significantly during the decline of the bloom, probably due to a change of the dominant algal species. During the peak of the spring bloom in 1988, the total algal biomass, primary productivity and net exudation amounted to 1.8 g C/sq m, 1 g C/sq m/d and 30 mg C/sq m/d, respectively. Bacterial productivity, determined by means of (H-3)-thymidine incorporation, was about 40 mg C/sq m/d in the euphotic zone, and bacteria obtained about 20% of their carbon via (C-14)-exudate uptake. (Author's abstract)  
W91-01592

**FATE OF PHYTOPLANKTON PRIMARY PRODUCTION: LOSSES IN RELATION TO BACTERIAL METABOLISM IN A EUTROPHIC SHALLOW LAKE.**

Akademie der Wissenschaften der DDR, Berlin. Dept. of Hydrology.  
For primary bibliographic entry see Field 2K.  
W91-01593

**PRODUCTION AND UTILIZATION OF ORGANIC MATTER BY MICROPLANKTON IN AN EUTROPHIC LAKE.**

Warsaw Univ. (Poland). Dept. of Environmental Microbiology.  
W. Siuda, and R. Wcislo.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 67-73, 1990. 3 fig, 2 tab, 14 ref. Project CPBP 04.02.3.1.1. (Poland).

Descriptors: \*Aquatic bacteria, \*Dissolved organic carbon, \*Eutrophic lakes, \*Limnology, \*Phytoplankton, Algae, Bacterial physiology, Carbon cycle, Dissolved solids, Lake Mikolajskie, Mazurian Lake District, Photosynthesis, Poland, Primary production, Radioactive tracers, Respiration.

Production and utilization of photosynthetic organic matter were studied in the pelagic zone of the highly eutrophic Lake Mikolajskie, Mazurian Lake District, Poland. About 97% of the total fixed (C-14)-carbon dioxide (TFC) was incorporated photosynthetically by algal cells, and 3% was fixed by microplankton in darkness. In the course of photosynthesis about 20% of TFC was released into the water, about 10% was respired, and about 70% remained in the microplankton particulate fraction (POC). The chemical composition of POC produced was strongly dependent on light conditions during photosynthesis. Radiocarbon was mainly incorporated into water soluble low molecular weight compounds (LMWC) and polysaccharide fractions. An increased contribution of proteins and lipids to POC was found when algal photosynthesis was light limited. Released organic carbon and the LMWC fraction of POC were preferentially utilized by aquatic bacteria. Supplementation of water samples with LMWC stimulated the bacterial growth rates and production. (Author's abstract)  
W91-01594

**AUTOTROPHIC AND HETEROTROPHIC ATP POOLS IN MICROBIAL COMMUNITIES: SUGGESTIONS FOR SEPARATION AND FOR BACTERIAL GROWTH RATE EVALUATION.**

Parma Univ. (Italy). Ist. di Ecologia.  
For primary bibliographic entry see Field 5A.  
W91-01595

**ECOLOGICAL ASPECTS OF ENZYME REGULATION IN AQUATIC BACTERIA.**

Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Abt. Mikrobiologie.  
J. Overbeck, and Y. Sako.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 81-92, 1990. 5 fig, 3 tab, 32 ref.

Descriptors: \*Aquatic bacteria, \*Bacterial physiology, \*Biochemical analysis, \*Enzymes, \*Limnology, \*Physiological ecology, Bacterial analysis, Ecology, Enzyme regulation, Heterotrophic bacteria, Phosphoenolpyruvate carboxylase, Tricarboxylic acid cycle.

The development and structure of aquatic heterotrophic bacterial populations is to a great extent determined by the availability of carbon sources. Environmental changes in the supply and substrate diversity of dissolved organic matter may occur within seconds or minutes and therefore, survival may depend on biochemical adaptations which must occur at the same fast rates. Some ecological aspects of enzyme regulation in aquatic bacteria were reviewed. The two basic types of enzyme regulation are quantitative and qualitative regulation. The tricarboxylic acid (TCA) cycle is one of the most important regulatory networks of the cell for catabolic and anabolic pathways. Phosphoenolpyruvate (PEP) carboxylase is not only involved in modifications of photosynthetic pathways, but can be considered one of the most important carboxylating enzymes in plants and microorganisms with manifold functions. Without PEP as the carbon dioxide acceptor and with pyruvate, carbon dioxide fixation is negligible, suggesting the involvement of PEP carboxylase in the reaction. PEP carboxylase, a tetramer, is allosterically regulated in a cooperative manner. A model of PEP carboxylase regulation in the bacterial cell features PEP as a substrate used for production of oxaloacetate and pyruvate through different channels; allosteric regulation by PEP; acetyl-CoA as a strong activator of the enzyme, thus promoting TCA reactions; and feedback inhibition by aspartate and malate. (MacKeen-PTT)  
W91-01596

**SUBSTRATE-ECTOENZYME INTERACTION: SIGNIFICANCE OF BETA-GLUCOSIDASE ACTIVITY FOR GLUCOSE METABOLISM BY AQUATIC BACTERIA.**

Warsaw Univ. (Poland). Dept. of Environmental Microbiology.  
R. J. Chrost, and J. Overbeck.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 93-98, 1990. 2 fig, 12 ref. Project CPBP 04.02.3.1. (Poland).

Descriptors: \*Algal blooms, \*Aquatic bacteria, \*Bacterial physiology, \*Enzymes, \*Eutrophic lakes, \*Extracellular metabolism, \*Glucose, \*Limnology, Beta-glucosidase, Glucose metabolism, Heterotrophic bacteria, Phytoplankton, Secondary productivity, Substrates.

Activity of beta-glucosidase (beta-GlcA), the enzyme that hydrolyses beta-linked disaccharides of glucose and liberates free glucose, was studied in a eutrophic lake during the spring algal bloom. Beta-GlcA was produced by heterotrophic bacteria and its activity correlated positively with bacterial secondary production and glucose incorporation. The highest beta-GlcA was associated with the phytoplankton bloom breakdown. Beta-GlcA was under control of a repression/induction mechanism, and the synthesis became depressed when the level of easily assimilated substrates had fallen below a critically low level. The enzymatic liberation of glucose in close vicinity to the bacterium may create and sustain high glucose concentrations near the cell surface. The active transport system of the cell membrane can be exposed to an increased concentration gradient of glucose, which facilitates its rapid uptake. (Author's abstract)  
W91-01597

**ASSIMILATION OF FREE MONOSACCHARIDES AND AMINO ACIDS RELATIVE TO BACTERIAL PRODUCTION IN EUTROPHIC LAKE WATER.**

Kongelige Veterinaer- og Landbohøjskole, Copenhagen (Denmark). Inst. of Microbiology.  
N. O. G. Jørgensen.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 99-110, 1990. 7 fig, 32 ref.

Descriptors: \*Aquatic bacteria, \*Bacterial physiology, \*Bacterial productivity, \*Eutrophic lakes, \*Limnology, \*Nutrients, Amino acids, Fructose, Glucose, High performance liquid chromatography, Nutrient assimilation, Nutrient concentrations.

Bacterial assimilation of dissolved free glucose, fructose and amino acids was studied in two eutrophic lakes and in a laboratory experiment. The assimilation rates were related to the actual bacterial production. Natural concentrations of free glucose and fructose in the lakes were measured combining separation by high performance liquid chromatography with a post-column color reaction of the saccharides. Free amino acids were quantified as fluorescent derivatives. Concentrations of free glucose, fructose and amino acids in the lakes were 33-95 nM, 7-55 nM and 6-34 nM, respectively. In the three studies assimilation (respiration + incorporation) of the organic compounds on the average sustained 6.7, 11 and 61% of the bacterial carbon requirement. Glucose was the predominant compound assimilated, followed by either fructose or amino acids. A comparison of concentration changes and assimilation rates demonstrated that a large production of both monosaccharides and amino acids occurred during the experiments. Generally the bacterial production varied independently of concentrations and assimilation rates of the tested organic compounds. (Author's abstract)  
W91-01598

**APPLICATION OF THE ISOTOPE DILUTION PRINCIPLE TO THE DETERMINATION OF SUBSTRATE INCORPORATION BY AQUATIC BACTERIA.**

Warsaw Univ. (Poland). Dept. of Environmental Microbiology.  
R. J. Chrost.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 111-117, 1990. 3 fig, 2 tab, 13 ref. Project CPBP 04.02.3.1. (Poland).

Descriptors: \*Aquatic bacteria, \*Bacterial physiology, \*Chemical analysis, \*Eutrophic lakes, \*Limnology, \*Nutrients, Amino acids, Analytical methods, Glucose, Isotope studies, Isotopic tracers, Leucine, Nutrient assimilation, Nutrient concentrations, Phytoplankton.

Isotope dilution analysis was used for the estimation of incorporation of (C-14)-glucose, (H-3)-leucine and (C-14)-protein hydrolysate by bacterioplankton in eutrophic lakes. Unlabeled glucose, leucine, or leucine-containing peptides in lake water significantly lowered apparent incorporation of (C-14)-glucose and (H-3)-leucine, respectively. Similar results were obtained in experiments in which the effect of casein hydrolysate and peptides on (C-14)-protein hydrolysate uptake by aquatic bacteria were studied. The apparent incorporation of labeled substrates was lower because radiolabels were isotopically diluted (thus had lower specific activity) by unlabeled glucose, leucine or amino acids resulting from extracellular and/or intracellular hydrolysis of the naturally present macromolecules containing these compounds. In the photic zone of eutrophic lakes, natural pools of glucose and leucine varied strongly from 115 to 726 nM, and from 12 to 135 nM, respectively. The largest pools of glucose and leucine were observed during the phytoplankton mass development. (Author's abstract)  
W91-01599

**CLAY, DISSOLVED ORGANIC MATTER, AND BACTERIAL INTERACTIONS IN TWO RESERVOIRS.**

Baylor Univ., Waco, TX.  
O. T. Lind, and L. O. Davalos.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 119-125, 1990. 1 fig, 1 tab, 31 ref.

Descriptors: \*Aquatic bacteria, \*Bacterial productivity, \*Clays, \*Dissolved solids, \*Limnology,

\*Reservoirs, Bacterial physiology, Organic matter, Phytoplankton, Regression analysis, Temperature, Texas, Turbidity.

The concentration of suspended clays as well as the concentration of dissolved organic matter (DOM) was shown to be an important variable in determining the rate of specific bacterial production (thymidine incorporation). Evidence for this conclusion comes from two subtropical Texas reservoirs. Sampling stations were selected to provide a range of inorganic turbidities, organic content, and trophic state. Stepwise multiple regression analysis was used to determine the percent variation in specific bacteria production that could be explained by a suite of environmental variables (turbidity, temperature, total and dissolved organic matter, and phytoplankton mass). For the composite data set (33 cases), phytoplankton mass (as chlorophyll a) explained 36% of the variation in bacterial production with DOC explaining an additional 3%. However, when data from the most turbid station were evaluated, 77% of the variation in bacterial production was explained by the turbidity with an additional 14% explained by the concentration of DOM. At the most turbid station, the number of clay-associated bacteria as a percent of total bacteria was directly related to the content of particulate organic carbon but not to DOC. The relationship of clay and DOM to bacterial production often may have been overlooked due to the low inorganic turbidities present in most of the marine and freshwater ecosystems investigated previously. This concept is important to the understanding of the trophic ecology of reservoirs, and other turbid ecosystems, where light limitation of phytoplankton occurs. (Author's abstract)  
W91-01600

**INPUT AND MINERALIZATION OF ORGANIC CARBON IN LAKES.**

Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.  
P. Casper.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 131-135, 1990. 2 fig, 2 tab, 9 ref.

Descriptors: \*Decomposition, \*Lakes, \*Limnology, \*Litter, \*Mineralization, \*Organic carbon, Carbon cycle, Germany, Lake Stechlin, Macrophytes, Microorganisms, Oligotrophic lakes, Organic matter.

The input of large airborne coarse particulate matter into the oligotrophic Lake Stechlin (East Germany) was investigated. In autumn 1985 this input reached 18.0 t of organic carbon and increased to about 125.0 t if decomposition of macrophytes was taken into account. The decomposition rate of beech litter (*Fagus sylvatica*) was about five-fold lower than the rate of the macrophyte *Potamogeton lucens*. The incubation of beech litter in other lakes (acidotrophic, eutrophic) or in Lake Stechlin during summer did not result in any change in decomposition rate. Dynamics of different parameters (bacterial numbers, uptake rate of glucose and acetate, dissolved organic carbon, ortho-phosphate and others) during the decomposition of beech litter and macrophytes showed a leaching loss of material up to 10% in the first hours, an increase of microbial activity in the first 10 days followed by a decrease up to day 35, and a relatively constant period. (Author's abstract)  
W91-01601

**STUDIES ON THE DECOMPOSITION OF LIGNOCELLULOSIC CARBON IN A FLOODED RICEFIELD SOIL.**

Parma Univ. (Italy). Ist. di Ecologia.  
P. Viaroli, I. Fumagalli, M. Cavalca, and F. Sartore.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 137-142, 1990. 2 fig, 5 tab, 10 ref.

Descriptors: \*Artificial wetlands, \*Carbon cycle, \*Cellulose, \*Decomposing organic matter, \*Organic carbon, \*Rice fields, \*Saturated soils, \*Wetlands, Adenosine triphosphate, Bacterial physiology,

## Field 2—WATER CYCLE

### Group 2H—Lakes

gy, Decomposition, Limnology, Metabolism, Nitrogen, Organic matter, Sediments, Trophisms.

Research on the decomposition of raw cellulose materials was carried out in a rice field during the submergence period. The experimental approach consisted of adding powdered wheat straw as recalcitrant matter to the surface sediment inside the enclosures. The decomposition rates and the amount of residual carbon seem to depend upon the initial C/N ratio. The higher the carbon concentration added, the higher the microbial respiratory metabolism and adenosine triphosphate, and the lower the pH and Eh values, both in water and sediments. The results indicated that nitrogen was an important factor in controlling straw decomposition, and that high inputs of organic matter may, at least initially, considerably modify the trophic status of the environment as a whole. (Author's abstract)

W91-01602

#### REACTION OF MICROBIAL PERIPHYTON TO SUBSTRATE CONCENTRATION CHANGES IN A RUNNING WATER MODEL. Vyzkumny Ustav Vodohospodarsky, Prague (Czechoslovakia).

P. Puncocchar.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 143-144, 1990. 1 tab, 7 ref.

Descriptors: \*Aquatic bacteria, \*Nutrients, \*Periphyton, \*Stream ecology, \*Streams, Bacterial physiology, Bioindicators, Ecosystems, Heterotrophic bacteria, Nutrient concentrations.

Microbial attachment to submerged surfaces and the development of attached communities (periphyton) are of great importance for running water ecosystems. The response of attached microbial communities to changes of nutrient concentration in water was studied under natural stream conditions. The heterotrophic bacteria counts increased by 1-2 orders of magnitude in the periphyton within 24-48 h of peptone dosing (1-2 mg/L final concentration) and reached 1,400,000/sq cm and 1,050,000/sq cm in the experimental periphyton and in the epilithon, respectively. Thus, the average bacterial periphyton growth rate was estimated at 0.05/h during the first five days of peptone dosing. Significantly higher counts of heterotrophic bacteria were found 72-96 h after stopping treatment. After 25 days of phosphate dosing (0.1-0.5 mg/L phosphate-P), chlorophyll a in experimental periphyton reached approximately twice the control level, while heterotrophic bacteria counts were not substantially increased. The attached microbial communities proved to be both a sensitive and stable indicator of substrate and nutrient concentrations in running waters. (MacKeen-PTT)

W91-01603

#### EFFECT OF PERIODIC ILLUMINATION ON NITRIFICATION IN THE CONTINUOUS CULTIVATION.

South Bohemian Biological Centre, Ceske Budejovice (Czechoslovakia).

J. Vrba.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 145-150, 1990. 2 fig, 1 tab, 14 ref.

Descriptors: \*Aquatic bacteria, \*Light effects, \*Limnology, \*Nitrification, \*Photoinhibition, Ammonia, Bacterial physiology, Culturing techniques, Kinetics, Nitrates, Substrates.

Light is a major factor influencing biological nitrification in natural waters. The effect of photoinhibition was studied in the laboratory in long-term continuous cultures of nitrifying bacteria from river water. The continuous culture was stabilized in the dark at 27°C. In all cultures, a successive development of ammonia and nitrate oxidation was observed. Ammonia was fully oxidized to nitrate by the 26th day, and the chemostat was changed to 12 h light/12 h dark cycles at the 27th day. An obvious increase of substrate concentration occurred during the next 8 days. Ammonia concentration decreased during dark periods and increased during light periods. When the light was

discontinued, nitrification rates fully recovered in a few days. The course of photoinhibition of both nitrate and ammonia oxidation appeared to follow first-order reaction kinetics. Photoinhibition of autotrophic nitrification should be considered in field studies, especially in shallow transparent water. (MacKeen-PTT)

W91-01604

#### IMPROVED ASSESSMENT OF BACTERIAL PRODUCTION: COMBINED MEASUREMENTS OF PROTEIN SYNTHESIS VIA LEUCINE AND CELL MULTIPLICATION VIA THYMIDINE INCORPORATION.

Konstanz Univ. (Germany, F.R.). Limnological Inst.

M. Simon.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 151-155, 1990. 23 ref.

Descriptors: \*Analytical methods, \*Aquatic bacteria, \*Bacterial analysis, \*Bacterial productivity, \*Limnology, \*Proteins, Bacterial physiology, Bacterial protein production, Biomass, Growth rates, Isotopic tracers, Leucine incorporation, Thymidine incorporation.

The recent introduction of the bacterial protein production (BPP) method using (H-3)-leucine incorporation has been shown to be a valuable complement to bacterial production measurements by the (H-3)-thymidine incorporation (TdR) method. It measures directly bacterial biomass production and provides an independent examination of the magnitude of TdR measurements, which are still somewhat controversial due to the variability of TdR-conversion factors not being completely understood. Variation in (H-3)-TdR intracellular isotope dilution which cannot be determined directly presumably affects this factor greatly. Since the BPP method allows measurement of (H-3)-leucine intracellular isotope dilution, leucine-BPP conversion factors can be determined directly. Thus, using both (C-14)-leucine and (H-3)-TdR in a double labeling technique, BPP and cell multiplication rates can be measured simultaneously in the same sample. Besides the direct determination of a BPP conversion factor, this allows indirect calculation of a conversion factor for TdR. It further allows calculation of the amount of protein per newly synthesized cell. This ratio, which is responsive to changing growth conditions of bacteria, may provide a more detailed insight into the growth dynamics of aquatic bacterial assemblages. (Author's abstract)

W91-01605

#### BACTERIAL NET PRODUCTION APPROACHING ZERO—A FREQUENT PHENOMENON IN PELAGIC ENVIRONMENTS.

Staatliches Inst. fuer Seenforschung und Fischereiwesen, Langenargen (Germany, F.R.).

H. Gude.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 165-169, 1990. 26 ref.

Descriptors: \*Aquatic bacteria, \*Bacterial physiology, \*Bacterial productivity, \*Growth rates, \*Limnology, \*Plankton, Analytical methods, Bacterial analysis, DNA, Lake Constance, Nucleic acids, Secondary productivity.

It has been suggested that bacterial populations represent a very productive part of planktonic communities. However, three independent estimates for Lake Constance show mean doubling times of epilimnetic bacteria in excess of 10 d during the warm season. Low productivity was also indicated by very low bacterioplankton RNA/DNA ratios. High bacterial production also cannot be reconciled with the low bacterial growth efficiencies observed under natural conditions. This apparent disagreement with the current view may be mainly due to two reasons: (1) Because of morphological and physiological changes observed frequently during incubation, the suitability of dilution experiments for estimates of in-situ growth can be questioned. (2) As shown by starvation experiments, biosynthesis is not identical with growth. A thorough reconsideration of current in situ growth estimates is recommended. (Author's abstract)

W91-01606

#### MICROBIAL ACTIVITIES IN A NATURALLY ACIDOTROPHIC LAKE.

Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.

H. D. Babenzien, and C. Babenzien.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 175-181, 1990. 3 fig, 2 tab, 22 ref.

Descriptors: \*Acid lakes, \*Aquatic bacteria, \*Bacterial physiology, \*Carbon cycle, \*Limnology, Bacterial analysis, Carbon dioxide, Carbon metabolism, Germany, Glucose, Hydrogen ion concentration, Isotopic tracers, Lake Fuchskuhle, Methane bacteria, Microbiological studies, Mineralization, Phytoplankton, Sediments.

Microbiological investigations were performed in Lake Fuchskuhle, a small acid forest lake (1.5 ha, 5.5 m maximum depth, 4.2-4.6 pH) in the Lake Stechlin area, East Germany. In view of a relatively constant number of bacteria (1,300,000/ml, acridine-orange direct count), an unexpectedly high amplitude of uptake rates (0.003-1.67 microg C/L/h, (C-14)-glucose) was observed in the water column. The uptake rates seemed to be closely correlated with phytoplankton primary production. Experiments with artificially-altered water resulted in a decrease in uptake rates with increasing pH values. The water-sediment interface showed oxic conditions. Carbon mineralization rates in the upper 5 cm of sediment were 10-100 times greater than those measured in the overlying water. Methylobacterial concentrations of up to 29,000,000/L were measured at the sediment surface. The bacterial carbon dioxide production was assumed to be an essential element of carbon metabolism in this extreme environment. (Author's abstract)

W91-01607

#### BACTERIAL PRODUCTIVITY IN SEDIMENTS.

Commonwealth Scientific and Industrial Research Organization, Cleveland (Australia). Marine Labs. D. J. W. Moriarty.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 183-189, 1990. 1 fig, 24 ref.

Descriptors: \*Analytical methods, \*Bacterial physiology, \*Bacterial productivity, \*Heterotrophic bacteria, \*Limnology, \*Sediments, DNA, Growth rates, Isotopic tracers, Sediment analysis, Thymidine uptake.

The growth of heterotrophic bacteria can be determined with reasonable accuracy with the thymidine method, provided certain conditions are adhered to during the experiment. As this is a pulse label method, the incubation time must be kept short to ensure that DNA is the only macromolecule labeled and that its rate of synthesis is not changed by disturbance of the sediment. The concentration of added thymidine must be high enough to prevent isotope dilution: in water about 20 nM and in sediment about 20 microM. Although more accurate factors for converting rates of DNA synthesis to numbers of dividing bacteria need to be determined by further research, the factors seem to lie within the theoretical range (0.25 to 0.8 quintillion). Higher factors would indicate either a deficiency in the methods for measuring rates of thymidine incorporation into DNA or the presence of a rapidly growing population of bacteria that cannot take up thymidine. Values for bacterial productivity in sediments, determined by the thymidine method, agree well with estimates from other methods and also with the amount of carbon supplied by primary producers. (Author's abstract)

W91-01608

#### NUMBERS AND ACTIVITY OF BACTERIOPLANKTON IN VARIOUS TYPES OF WATERS IN CZECHOSLOVAKIA: RELATIONS TO CHLOROPHYLL CONCENTRATION.

Vyzkumny Ustav Vodohospodarsky, Prague

(Czechoslovakia).

J. K. Fuksa.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 203-208, 1990. 1 fig, 18 ref.

Descriptors: \*Bacterioplankton, \*Chlorophyll, \*Czechoslovakia, \*Fish ponds, \*Lakes, \*Limnology, \*Reservoirs, Aquatic bacteria, Bacterial physiology, Biomass, Glucose uptake, Phytoplankton, Regression analysis, Stagnant water, Substrates, Trophic level.

Numbers, biomass, activity and production of bacterioplankton generally increase with the trophic state of water ecosystems in most of which phytoplankton is the primary source of substrates for bacterioplankton. Direct counts of bacteria (DC), maximal velocity of (C-14)-glucose uptake per liter (V(max)) and per unit of DC (V(max spec)) were related to chlorophyll a concentration (CHL) in 104 samples representing all types of stagnant waters in Czechoslovakia: alpine and subalpine lakes, various types of reservoirs and productive fishponds. Total range of CHL was 0.03-1098 microg/L. Linear regression equations were obtained showing good correlation of DC and V(max) to phytoplankton biomass; V(max spec), calculated per unit of bacterial count, was relatively independent of CHL. Results showed that activity in bacterioplankton is regulated at the cellular level and supply of substrates to an individual or 'mean' cell is a more important factor than the general trophic state of a water body. (Author's abstract)

W91-01610

#### BACTERIAL PRODUCTION AND RESPIRATION IN THE LAKES OF DIFFERENT TYPES, Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.

V. G. Drabkova.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 209-214, 1990. 4 fig, 2 tab, 6 ref.

Descriptors: \*Agricultural runoff, \*Aquatic bacteria, \*Bacterial physiology, \*Bacterial productivity, \*Bacterioplankton, \*Lakes, \*Limnology, \*Nutrients, \*Respiration, Agriculture, Biomass, Glucose uptake, Latvian elevation, Latvia, Phosphorus, Trophic level, USSR.

Limnological surveys were conducted from 1977 to 1984 in 14 lakes of the Latvian elevation in eastern Latvia. The principal aim of the investigation was to assess changes in lake productivity due to intensified agricultural transformations of the watersheds. Increased phosphorus loading was found to provoke a rise in lake bioproductivity. This resulted in the augmentation of the total number (N) and biomass (B) of bacterioplankton. The annual bacterial production (P) was well correlated with phosphorus loading at the lake. At the same time a direct dependence of the annual bacterial production on primary phytoplankton was not found. The intensity of bacterial respiration (R) increased with increasing trophic level, to a certain limit. In highly productive lakes the intensity of bacterial respiration was rather low. The specific activity of bacterioplankton (P/B, R/B) decreased with increasing trophic level. In highly productive lakes the maximal uptake rate of glucose per individual bacterial cell also decreased. (Author's abstract)

W91-01611

#### MODELLING SEASONAL CHANGES OF EPI-LIMNETIC BACTERIA ON THE BASIS OF PHYTO- AND ZOOPLANKTON DYNAMICS, South Bohemian Biological Centre, Ceske Budejovice (Czechoslovakia).

V. Straskrabova, K. Simek, and J. Komarkova. Ergebnisse der Limnologie ERLIA6, Vol. 34, p 229-235, 1990. 1 fig, 1 tab, 22 ref.

Descriptors: \*Aquatic bacteria, \*Limnology, \*Model studies, \*Phytoplankton, \*Population dynamics, \*Zooplankton, Bacterial physiology, Bacterial productivity, Biomass, Czechoslovakia, Mesotrophic lakes, Primary productivity, Protozoa, Reservoirs, Rimov Reservoir.

In a mesotrophic reservoir, Rimov Reservoir in Czechoslovakia, the seasonal dynamics of bacteria in the surface layer were followed from April to October and related to phytoplankton biomass and production and to zooplankton biomass. Phytoplankton available for zooplankton grazing was distinguished according to the sizes of the cells and colonies (40 microm diameter). Bacterial production due to extracellular exudates from healthy phytoplankton cells was calculated from the early spring data and found to equal 1.4% of net primary production. Bacterial production from zooplankton excreta was correlated with both available phytoplankton and cladoceran biomasses. It corresponded to 10.5% of available phytoplankton biomass per day. Elimination of bacteria by protozoans was measured directly for the whole season and elimination by bacterivorous zooplankton (rotifers and cladocerans smaller than 710 microm) was calculated on the basis of several experiments. The clearance rates of zooplankton feeding on bacteria were 20% of those feeding on available phytoplankton. For the whole ten-month period, the epilimnetic bacterial production reached 2.08 g C/cu m, which equaled 7% of gross primary production; 12% of bacterial production originated from algal extracellular release, the rest was from zooplankton excreta. Of the total elimination, 8% was due to protozoans and 92% due to zooplankton. (Author's abstract)

W91-01612

#### NOTE ON THE MEASUREMENT OF PRODUCTION OF PHOTOTROPHIC BACTERIA IN DEEP LAYERS.

Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.

C. L. M. Steenbergen, and P. van den Hoven.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 249-255, 1990. 2 fig, 1 tab, 19 ref.

Descriptors: \*Analytical methods, \*Aquatic bacteria, \*Bacterial physiology, \*Bacterial productivity, \*Lakes, \*Limnology, Anaerobic conditions, Biological samples, Biomass, Chlorophyll, Deep water, Lake stratification, Light intensity, Limiting factors, Oxygen, Photosynthesis, Phototrophic bacteria, Sample preparation, Sulfides.

Production measurements of deep phototrophic bacterial assemblages, found at the oxygen-sulfide interface of productive stratified lakes, are often frustrated by the simultaneous occurrence of oxygenic and anoxygenic forms which pose problems of the collection of samples and their manipulation. Also, contact of deep water samples with air needs to be avoided. The two types of photosynthesis were measured in separate samples using 3-3,4-dichlorophenyl-1,1-dimethylurea (DCMU) as an inhibitor of the oxygenic photosynthesis in one sample series. For reliable biomass determinations in terms of chlorophyll a and bacteriochlorophylls, chromatographic techniques were employed to isolate the various compounds enabling calculation of their concentrations separately. Ideally production values should be expressed in relation to other parameters such as biomass and light intensity. In addition, sulfide limitation of the anoxygenic photosynthesis should be considered also. (Author's abstract)

W91-01614

#### TROPHIC RELATION IN THE MICROZOOPLANKTON COMMUNITY.

Akademiya Nauk SSSR, Leningrad. Zoologicheskii Inst.

E. B. Pavelieva.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 257-261, 1990. 3 fig, 2 tab, 11 ref.

Descriptors: \*Food chains, \*Lakes, \*Limnology, \*Trophic level, \*Zooplankton, Algal blooms, Aquatic bacteria, Copepods, Dalnee Lake, Detritus, Feeding rates, Kamchatka, Microzooplankton, Plankton, Primary productivity, Protozoa, Rotifers, Seasonal variation, Succession, USSR.

The differential estimation of participation by some microzooplankton groups in food consumption was given for a seasonal cycle of observation for Dalnee Lake, Kamchatka, USSR. The succession

in the planktonic community of the lake has a two-phase character and passes through autotrophic and heterotrophic phases. The utilization of primary production by microzooplankton was possible only during the spring development of algae. Then, in the heterotrophic phase, detritus was utilized for the dissipation of organic matter in the food chain. The animals' daily ration increased 2-10 times as much as the production of phytoplankton and the summer biomass of food resources was considerably higher than its consumption. During 5 months, the harvest of heterotrophic organisms comprised: bacteria, 50 g C/sq m; flagellates, 5 g C/sq m; ciliates, 10 g C/sq m; herbivorous rotifers, 2 g C/sq m; and nauplii of copepods, 3 g C/sq m. The efficiency of utilization of the potential food objects by the microzooplankton community was 7%, and by the whole filtering plankton, 17%. (Author's abstract)

W91-01615

#### HETEROTROPHIC MICROPLANKTON IN PLANKTON SUCCESSIONS AND SELF PURIFICATION PROCESSES ALONG THE YENISEI RIVER.

Oceanology Dept., Gelendzhik, Krasnodar, 353470 USSR.

Y. I. Sorokin.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 267-273, 1990. 4 fig, 2 tab, 8 refs.

Descriptors: \*Dam effects, \*Food chains, \*Hydroelectric plants, \*Plankton, \*Rivers, \*Stream ecology, \*Succession, \*Yenisei River, Aquatic bacteria, Biomass, Decomposition, Dilution, Ecosystems, Microplankton, Organic matter, Protozoa, Self-purification, USSR, Zooplankton.

The self-purification processes in aquatic environments proceed as the result of functioning of an intact ecosystem, which includes all the components of the food chain. During the study of these processes in the Yenisei River, from the Krasnoyarsk hydropower station to the port of Igarka, the roles of heterotrophic microplankton as a component of the river ecosystem were investigated. The river water below the gate of the Krasnoyarsk hydropower station was extremely poor in microplankton, possibly due to the destruction of plankton by the cavitation process in turbines. The decrease in zooplankton biomass inhibited the self-purification process. The nongrazed microbial biomass accumulated in the river water between Krasnoyarsk up to the Angara River mouth, was then actively grazed and decomposed in the middle part of the river below Yartzevo, where a mass development of microzooplankton (mainly ciliates) took place. Below the Angara River mouth, a mass bloom of diatoms occurred and the primary production soon reached its maximum (up to 400 mg C/cu m/d). In the lower part of the river a mature and rich planktonic community was formed, which provided decomposition of about 8 g/sq m/d of organic matter. The processes of self-purification in the plankton community of the Yenisei River proceeded mainly within the food chain: bacteria-zooflagellates-ciliates. (MacKeen-PTT)

W91-01616

#### UPTAKE OF BACTERIA-SIZED FLUORESCENT PARTICLES BY NATURAL PROTOZOAN ASSEMBLAGE IN A RESERVOIR.

Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.

K. Simek, M. Macek, and V. Vynalek.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 275-281, 1990. 2 fig, 2 tab, 23 ref.

Descriptors: \*Bacterioplankton, \*Flagellates, \*Food chains, \*Limnology, \*Protozoa, \*Reservoirs, Aquatic bacteria, Czechoslovakia, Fluorescent particles, Ingestion, Rimov Reservoir, Seasonal variation.

The potential impact of ciliates and heterotrophic nanoflagellates (HNF) on bacterioplankton in the Rimov Reservoir was studied from April until October 1987 using inert fluorescent particles (FP). HNF (500-1280/ml) were the dominant micrograzers during the spring period and grazed 3 to

## Field 2—WATER CYCLE

### Group 2H—Lakes

9% of bacterial standing stock daily. The average ingestion rate based on HNF with ingested FP (3.3-48% of the total) ranged from 7-28 bacteria/cell/h. During the spring, <25% of the total ciliates ingested FP, with average ingestion rates of 7-44 bacteria/cell/h. A drastic decrease in protozoan density occurred during the clearwater phase. Ciliates (15-142/ml) became the dominant micrograzers during summer with average ingestion rates ranging from 22-111 bacteria/cell/h (based on ciliates ingesting FP). During the period of peak ciliate abundance, the protozoan community grazed up to 21% of the bacterial standing stock daily. Egestion of FP by ciliates was insignificant. (Author's abstract)  
W91-01617

**SPHAGNUM-DOMINATED PEATLANDS OF THE HYPEROCEANIC BRITISH COLUMBIA COAST: PATTERNS IN SURFACE WATER CHEMISTRY AND VEGETATION.**  
Alberta Univ., Edmonton. Dept. of Botany.  
D. H. Vitt, D. G. Horton, N. G. Slack, and N. Malmer.  
Canadian Journal of Forest Research C/JFRAR, Vol. 20, No. 6, p. 696-711, June 1990. 8 fig, 3 tab, 61 ref. Natural Sciences and Engineering Research Council of Canada Grants A6390 and U0015.

Descriptors: \*British Columbia, \*Peat, \*Peatlands, \*Sphagnum, \*Water chemistry, \*Wetlands, Bogs, Canada, Classification, Coastal wetlands, Fens, Vegetation, Water level.

Vegetation from 133 relevés representing a broad spectrum of peatland types from the Prince Rupert area, British Columbia were divided into six releve groups. The 210 taxa found in these releve groups were classified into six species groups. In general, the species groups are related to one another along shade and height (above water level) gradients. Chemical and physiographic gradients that correlate with the releve distribution pattern on a detrended correspondence analysis ordination are: surface water chemistry, shade and height. In particular, the major gradient influencing the first axis of the ordination is shade. The second axis of the ordination is related to a complex chemical gradient in which hydrogen ion, calcium, and sulfate are the most important components. These chemical changes are influenced by ombrotrophy. Surface water chemistry patterns show enriched ionic conditions on Graham Island (Queen Charlotte Islands), with a decrease inland. Especially important is the decrease of sodium and chloride ions. The peatland studied include ombrotrophic bogs and soligenous fens. Raised bogs were found in basins, while blanket bogs occurred on gentle slopes at the most oceanic site. *Pinus contorta* Loud. var. *contorta* is most abundant at ombrotrophic sites, while *Chamaecyparis nootkatensis* Spach is dominant in soligenous fens. Soligenous poor fens, characterized by high Sphagnum abundance in lawns and forest islands, and a pH of 4.4-6.6, is the peatland type most frequently encountered in the study area. (Author's abstract)  
W91-01692

**STANDING-WATER DEPOSITS AS INDICATORS OF LATE QUATERNARY DUNE MIGRATION IN THE NORTHWESTERN NEGEV, ISRAEL.**  
Weizmann Inst. of Science, Rehovoth (Israel).  
Dept. of Isotope Research.  
For primary bibliographic entry see Field 2J.  
W91-01695

**ROLE OF AMMONIUM AND NITRATE RETENTION IN THE ACIDIFICATION OF LAKES AND FORESTED CATCHMENTS.**  
Ontario Ministry of the Environment, Dorchester.  
Dorset Research Center.  
For primary bibliographic entry see Field 5B.  
W91-01718

**METHANE EMISSIONS FROM FEN, BOG AND SWAMP PEATLANDS IN QUEBEC.**  
McGill Univ., Montreal (Quebec). Dept. of Geography.

For primary bibliographic entry see Field 5B.  
W91-01719

**SPATIAL AND TEMPORAL PATTERNS IN THE HYDROGEOCHEMISTRY OF A POOR FEN IN NORTHERN WISCONSIN.**  
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.  
L. E. Marin, T. K. Kratz, and C. J. Bowser.  
Biogeochemistry BIOGEP, Vol. 11, No. 1, p. 63-76, September 1990. 11 fig, 3 tab, 27 ref. NSF Grant BSR8514330.

Descriptors: \*Fens, \*Geochemistry, \*Geohydrology, \*Spatial distribution, \*Temporal distribution, \*Water chemistry, \*Wetlands, \*Wisconsin, Bogs, Conductivity, Dissolved organic carbon, Groundwater, Interstitial water, Peat, Seasonal variation.

The factors causing spatial and temporal patterning of interstitial water chemistry in Crystal Bog, a 7 ha northern Wisconsin kettle-hole peatland was studied. Over the course of the snow-free season Crystal Bog exhibited spatial and temporal patterns in chemistry, especially hydrogen-ion, dissolved organic carbon, and specific conductance. The peatland contains a 0.5 ha pond that has water more dilute than the interstitial water of the surrounding peatland. The direction of groundwater flow between the lake and the peatland was seasonally dependent. In the spring and early summer, flow was from the lake into the peatland, especially on the eastern side of the lake. This flow resulted in a plume of relatively dilute surface interstitial water in the peatland. In mid and late summer direction of groundwater flow was from the peatland into the lake and the dilute plume was reduced in areal extent. By fall the direction of water flow was again from the lake to the peatland. The spatial and temporal heterogeneity in water chemistry produced by the seasonal variation in the direction of horizontal water flow was substantial. Minimum and maximum observed concentrations of dissolved organic carbon (DOC) in the interstitial water of the peatland, for example, differed by more than a factor of three, and the pH ranged between 3.8 and 5.0. Correlations of DOC with anion deficit and hydrogen ion concentration and experiments of photo-oxidation of water samples showed that organic acids were the primary cause of acidity in the peatland. Specific conductance was highly correlated with DOC, probably because of DOC's correlation with the very conductive hydrogen ion. In Crystal Bog it was possible to use the relatively simple measure of specific conductance to estimate the temporal and spatial distribution of the more difficult to determine DOC. (Author's abstract)  
W91-01720

**RESPONSES OF PLANKTON AND NUTRIENTS TO METHYLENE BLUE-PHOTOSENSITIZED LAKE RESTORATION.**  
Nevada Univ., Reno. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5G.  
W91-01736

**INFLUENCE OF ORGANIC SEDIMENT AMENDMENTS ON GROWTH AND TUBER PRODUCTION BY POTAMOGETON PECTINATUS L.**  
Agricultural Research Service, Davis, CA. Aquatic Weed Control Research Lab.  
For primary bibliographic entry see Field 2I.  
W91-01740

**FATE OF ADDED N-15 LABELLED NITROGEN IN A SAGITTARIA LANCIFOLIA L. GULF COAST MARSH.**  
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.  
R. D. DeLaune, and C. W. Lindau.  
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 3, p. 265-268, June 1990. 2 fig, 1 tab, 8 ref. NSF Grant BSR-8414006.

Descriptors: \*Coastal marshes, \*Emergent aquatic plants, \*Gulf of Mexico, \*Nitrogen cycle, \*Wetlands, Arrowheads, Biomass, Detritus, Louisiana,

Nitrogen compounds, Path of pollutants, Radioisotopes, Tracers.

Response of *Sagittaria lancifolia* L. to added N-15 labeled nitrogen was studied in a Louisiana Gulf Coast freshwater marsh. The amount of the added labeled  $\text{NH}_4(+)-\text{N}$  remaining in the soil or plant tissue was determined several times during the growing season. Above-ground biomass increased by approximately 100 percent following the addition of 10 g  $\text{NH}_4(+)-\text{N}$  per square meter. There was no significant nitrogen loss from the soil during the growing season after the labeled inorganic nitrogen was apparently immobilized into the soil organic nitrogen pool. The N-15 balance data obtained from this study demonstrates that following the initial loss prior to the first sampling there is little nitrogen loss from the soil. Nitrogen losses were likely from the plant, either through leaching or physical transport of detritus remaining as a result of die-back that resulted from the growth cycles occurring during the season. The nitrogen loss reported is greater than previous nitrogen studies conducted in other marsh types in coastal Louisiana. Plant biomass response of *Sagittaria lancifolia* to added nitrogen was greater than that reported for other Louisiana coastal wetland plant species. (Agostine-PTT)  
W91-01741

**EFFECT OF NUTRIENT CONTENT ON LEAF DECOMPOSITION IN A COASTAL PLAIN STREAM: A COMPARISON OF GREEN AND SENESCENT LEAVES.**  
Savannah River Ecology Lab., Aiken, SC.  
L. G. Leff, and J. V. McArthur.  
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 3, p. 269-277, June 1990. 4 fig, 1 tab, 26 ref. U.S. D.O.E. Grant DE-AC09-76SR00-819.

Descriptors: \*Coastal plains, \*Coastal streams, \*Decomposing organic matter, \*Leaves, \*Nutrients, Bacteria, Biomass, Invertebrates, Maple trees, Riparian vegetation, Seasonal variation, Toxins.

Studies on leaf processing in temperate lotic environments have emphasized the importance of input of senescent leaves in the fall because of the large, obvious influx of riparian biomass at this time. Differences in processing have been found between species of leaves, and these differences have been attributed to thickness of the cuticle, presence of toxic or inhibitory compounds, and nutrient content. The decomposition of fresh-green and autumn-shed (senescent) red maple leaves (*Acer rubrum*) were compared in a low-gradient black-water stream. When the two types of leaves were incubated in the stream during the fall, there was no significant difference in processing rate. The invertebrate fauna was similar on the two leaf types and did not appear to affect decomposition. However, higher densities of invertebrates were found on green leaves during the final stage of decomposition. Bacterial densities were higher on senescent leaves than on green leaves during the initial phase of decomposition, although green leaves were richer in nutrients. Toxic or inhibitory compounds in the green leaves may override effects of nutrient enhancement on bacterial growth and leaf decomposition. (Agostine-PTT)  
W91-01742

**EFFECT OF SUBMERSED AQUATIC VEGETATION ON PHYTOPLANKTON AND WATER QUALITY IN THE TIDAL FRESHWATER POTOMAC RIVER.**  
George Mason Univ., Fairfax, VA. Dept. of Biology.

R. C. Jones.  
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 3, p. 279-288, June 1990. 2 fig, 1 tab, 24 ref.

Descriptors: \*Phytoplankton, \*Potomac River, \*Submerged aquatic plants, \*Tidal rivers, \*Vegetation effects, \*Water quality, Aquatic weeds, Biomass, Chlorophyll a, Dissolved oxygen, Hydrilla, Hydrogen ion concentration, Macrophytes, Seasonal variation.

Phytoplankton biomass and water quality were determined at two sites in the tidal freshwater Potomac River. At each site three plant treatments were sampled twice each during the summer and the fall. Phytoplankton biomass, as measured by chlorophyll *a*, was negatively related to macrophyte density. High density Hydrilla beds harbored the least phytoplankton chlorophyll, while low density mixed beds were most similar to the open water areas. This effect was more pronounced in summer than in fall. Variation in dissolved oxygen and pH reflected the standing crop of both phytoplankton and macrophytes. Phytoplankton were the dominant influence in the open water; macrophytes were more important in the dense weedbeds. Greatest variation in temperature was observed in the dense weedbeds. (Author's abstract)  
W91-01743

#### COMPARISON OF DETRITUS PROCESSING BETWEEN PERMANENT AND INTERMITTENT HEADWATER STREAMS.

Central Michigan Univ., Mount Pleasant. Dept. of Biology.  
W. B. Richardson.  
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 3, p 341-357, June 1990. 6 fig, 5 tab, 55 ref. U.S. D.O.E. Contract DE-AC-09-76SR00819.

Descriptors: \*Decomposing organic matter, \*Detritus, \*Headwaters, \*Intermittent streams, \*Perennial streams, Alder trees, Ash trees, Biomass, Comparison studies, Food habits, Invertebrates, Leaves, Nitrogen, Seasonal variation.

The pattern of leaf pack decomposition and density and biomass of the associated invertebrate detritivore community of an intermittent and a perennially flowing headwater stream were compared in autumn and spring. Leaf packs of high (*Alnus rugosa*) and low (*Fraxinus americana*) nitrogen content were used. Leaf litter was processed at similar rates in both streams during autumn ( $k$ : 0.015 g/d). In spring the decomposition rates more than doubled in the permanent stream ( $k$ : 0.03) and only slightly increased in the intermittent stream (e.g. *Fraxinus*:  $k$ : 0.017). Differences in decomposition rates between leaf species were seen only in the fall in the intermittent stream where *Fraxinus* litter decomposed slower than *Alnus*. Shredder biomass was greater than other invertebrate guilds in both streams, was reduced in the intermittent stream, and varied with season (spring > fall), particularly in the permanent stream. Shredder biomass was greater in *Alnus* leaf packs. Shredder densities were significantly lower in the intermittent stream, during both seasons, compared with the permanent stream. Greater densities of shredders occurred on *Alnus* leaf packs. Collectors outnumbered other guilds. The intermittent stream had a depauperate shredder fauna and was numerically dominated by collectors. Lack of shredding detritivores, combined with decreased duration of submersion, resulted in reduced potential for processing of particulate carbon relative to the permanently flowing stream. (Author's abstract)  
W91-01744

#### NEW APPROACH FOR MEASURING COVER IN FISH HABITAT STUDIES.

Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.  
A. D. Kinsolving, and M. B. Bain.  
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 3, p 373-378, June 1990. 2 fig, 1 tab, 20 ref.

Descriptors: \*Aquatic habitats, \*Fish, Analytical techniques, Mathematical studies.

The most common method for measuring fish cover in fish habitat studies, percent area with cover, produces data that are difficult to analyze, incompatible with data on other habitat variables, frequently subjective, and limited in content. Alternative cover measurement methods used in marine habitats can be more widely used but retain some of the disadvantages of the percent area method. A new approach to measuring cover is based on counting the number of surfaces within a planar section of a water column. Rules for counting

surfaces were: (1) solid objects with a diameter greater than 10 cm were counted as two surfaces; (2) objects thinner than 10 cm were counted as a single surface; (3) objects located closer than 3 cm to each other were considered part of the same surface; (4) portions of a cover object which were geometrically separate were counted separately; (5) undercut banks were considered to be cover objects. These rules were designed for quantifying shallow, shoreline microhabitats primarily inhabited by numerous species of small fishes and the rules should be altered to accommodate different study objectives, target fish sizes and microhabitat types. This method is easy, fast, and produces data that can be used to compute three continuously distributed cover parameters: density, complexity, and heterogeneity. Field results are presented to demonstrate how this approach can be used to differentiate species in their use of cover in freshwater basins. (Agostine-PTT)  
W91-01746

#### BENTHIC MACROPHYTE COMMUNITY CORE SAMPLER.

Wayne State Univ., Detroit, MI. Dept. of Biological Sciences.  
For primary bibliographic entry see Field 7B.  
W91-01747

#### ISOLATION AND CHARACTERIZATION OF HEPATOTOXIC MICROCYSTIN HOMOLOGS FROM THE FILAMENTOUS FRESHWATER CYANOBACTERIUM NOSTOC SP. STRAIN 152.

Helsinki Univ. (Finland). Dept. of Microbiology.  
K. Sivonen, W. W. Carmichael, M. Namikoshi, K. L. Rinehart, and A. M. Dahlem.  
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 9, p 2650-2657, September 1990. 6 fig, 1 tab, 26 ref. USAMRIID Contract DAMD-17-87-C-7-19. Public Health Service Grants AI04769 and GM27029.

Descriptors: \*Cyanophyta, \*Eutrophic lakes, \*Finland, \*Lakes, \*Limnology, \*Pollutant identification, \*Toxins, High performance liquid chromatography, Mass spectrometry, Nostoc, Nuclear magnetic resonance.

A strain of the filamentous cyanobacterium *Nostoc* sp. isolated from a lake in Finland was found to produce at least nine hepatotoxic peptides with chemical and toxicological properties similar to those of the hepatotoxic hepta- and pentapeptides produced by other cyanobacteria. Toxins were isolated and purified by high-performance liquid chromatography. Amounts available for five of the purified toxins (P6, P14, P15, P16, and P18) were adequate for high-performance liquid chromatography amino acid analysis and determination of molecular weight by fast-atom bombardment-mass spectrometry (FAB-MS). Quantities of three toxins (P14, P15, and P16) were adequate for further analysis by high-resolution FAB-MS, FAB-MS/MS, and H1-nuclear magnetic resonance. Analysis showed that the toxins are new types of microcystin-LR homologs. Microcystin-LR contains equimolar amounts of D-alanine, L-leucine, D-erythro-beta-methylaspartic acid, L-arginine, ADDA (3-amino-9-methoxy-2,6,8-trimethyl-10-phenyl-4,6-decadienoic acid), D-glutamic acid, and N-methyl-dehydroalanine (molecular weight (MW), 994). *Nostoc* sp. strain 152 was found to produce the following microcystin-LR homologs: (1) P6 contains an extra methylene group most probably due to the presence of N-methyldehydrobutyryne instead of N-methyldehydroalanine (MW, 1008); (2) P14 is O-acetyl-O-demethyl ADDA-microcystin-LR (MW, 1,022); (3) P15 is 3-demethyl-O-acetyl-ADDA-homoarginine-microcystin-LR (MW, 1,036); (4) P16 is 3-demethyl-O-acetyl-O-demethyl-ADDA-microcystin-LR (MW, 1,008); (5) P18 is 3-demethyl-O-acetyl-O-demethylADDA-homoarginine-microcystin-LR (MW, 1,022). The toxicities of the new microcystin homologs were not significantly different from those of microcystin-LR or demethylmicrocystin-LR. (Author's abstract)  
W91-01761

#### DISTRIBUTION AND RATE OF METHANE OXIDATION IN SEDIMENTS OF THE FLORIDA EVERGLADES.

Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.  
G. M. King, P. Roslev, and H. Skovgaard.  
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 9, p 2902-2911, September 1990. 6 fig, 2 tab, 41 ref. NASA Grant NAGW-1406.

Descriptors: \*Everglades, \*Florida, \*Marsh plants, \*Methane, \*Oxidation, \*Sediments, \*Wetlands, Light penetration, Marl, Oxygen, Path of pollutants, Peat, Photosynthesis, Roots.

Rates of methane emission from intact cores were measured during anoxic dark and oxic light and dark incubations. Rates of methane oxidation were calculated on the basis of oxic incubations by using the anoxic emissions as an estimate of the maximum potential flux. This technique indicated that methane oxidation consumed up to 91% of the maximum potential flux in peat sediments but that oxidation was negligible in marl sediments. Oxygen microprofiles determined for intact cores were comparable to profiles measured in situ. Thus, the laboratory incubations appeared to provide a reasonable approximation of in situ activities. This was further supported by the agreement between measured methane fluxes and fluxes predicted on the basis of methane profiles determined by in situ sampling of pore water. Methane emissions from peat sediments, oxygen concentrations and penetration depths, and methane concentration profiles were all sensitive to light-dark shifts as determined by a combination of field and laboratory analyses. Methane emissions were lower and oxygen concentrations and penetration depths were higher under illuminated than under dark conditions; the profiles of methane concentration changed in correspondence to the changes in oxygen profiles, but the estimated flux of methane into the oxic zone changed negligibly. Sediment-free, root-associated methane oxidation showed a pattern similar to that for methane oxidation in the core analyses: no oxidation was detected for roots growing in marl sediment, even for roots of *Cladium jamaicense*, which had the highest activity for samples from peat sediments. The magnitude of the root-associated oxidation rates indicated that belowground plant surfaces may not markedly increase the total capacity for methane consumption. However, the data collectively support the notion that the distribution and activity of methane oxidation have a major impact on the magnitude of atmospheric fluxes from the Everglades. (Author's abstract)  
W91-01763

#### ALGAE, OTHER THAN DIATOMS, AFFECTING THE DENSITY, SPECIES RICHNESS AND DIVERSITY OF DIATOM COMMUNITIES IN RIVERS.

Zurich Univ., Kilchberg (Switzerland). Hydrobiological-Limnological Station.  
F. Elber, and F. Schanz.  
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 1, p 1-14, July 1990. 5 fig, 1 tab, 50 ref.

Descriptors: \*Algal growth, \*Diatoms, \*Periphyton, \*River ecology, \*Species diversity, \*Chlorophyta, \*Chrysophyta, \*Cyanophyta, Population density, Rivers, Species composition, Succession, Water pollution effects.

The influence on diatom communities of algae of other groups, including the chrysophyte *Hydrurus foetidus*, as well as green and blue-green algae, was examined by comparing the algal periphyton of river bottom stones with that of stones imported to the river bed. In spring, *H. foetidus* biomasses were higher on these imported stones than on river bottom stones; in contrast statistically greater densities of green and blue-green algae on river bottom stones were observed during the investigation period. The mass development of *Hydrurus* on imported stones diminished the densities of diatoms by reducing their growth rates as a consequence of less available light. According to the dynamic equilibrium hypothesis of Huston (1979), a higher diversity was therefore expected on imported

## Field 2—WATER CYCLE

### Group 2H—Lakes

stones than on river bottom stones; this was indeed the case. An increase in the species richness, evenness and diversity was observed. If *H. foetidus* was absent, the diatom communities on river bottom stones showed higher diversity values than those on imported stones. The much longer exposure time obviously enabled the biological systems to reach a more complex level. In order to avoid undesired effects in future investigations on the structure of diatom communities, sampling substrata lacking mass developments of algae other than diatoms should be selected. (Author's abstract) W91-01765

**STUDY OF AQUATIC COMMUNITY DYNAMICS IN A KARSTIC SYSTEM BY THE USE OF ARTIFICIAL SUBSTRATES.**  
Lyon-1 Univ., Villeurbanne (France). Lab. d'Hydrobiologie et Ecologie Souterraines.  
P. Vervier.  
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 1, p 15-33, July 1990. 10 fig, 2 tab, 61 ref.

Descriptors: \*Aquatic populations, \*Artificial substrates, \*France, \*Karst, \*Karst hydrology, \*Population dynamics, \*Species diversity, \*Aquifers, \*Colonization, \*Crustaceans, \*Flooding, \*Groundwater, \*Hydrologic data collections, \*Sampling.

The use of artificial substrates to study aquatic community dynamics in underground environments is more recent than in aquatic surface systems. An artificial substrate consisting of a synthetic rope (0.5 cm in diameter) stuffed into a 20-cm long polyvinyl chloride pipe (10 cm in diameter) containing 1-cm holes was placed in the Foussoûble karstic system of southeast France. Artificial substrates immersed during a one month period or, with less efficiency, during a two month period, showed that karst hydrology plays an important role in the dynamics of karstic system communities. The duration of immersion was less important than the hydrological period during which the artificial substrates were immersed. The importance of floods in the colonization process was demonstrated by the use of the artificial substrates. The artificial substrates placed in the sediments of the stream had higher population densities after a flood than during the low-water period. The use of artificial substrates showed that the number of organisms that settle in the bottom differed according to the facies of the stream (e.g. riffles and pools). Moreover, the artificial substrates method made the study of the migration of epigeic organisms into the karstic system possible. (Geiger-PTT) W91-01766

**BENTHIC COMMUNITY STRUCTURE AND THE EFFECT OF ROTENONE PISCICIDE ON INVERTEBRATE DRIFT AND STANDING STOCKS IN TWO PAPUA NEW GUINEA STREAMS.**

Hong Kong Univ. Dept. of Zoology.  
D. Dudgeon.

Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 1, p 35-53, July 1990. 7 fig, 3 tab, 27 ref, append.

Descriptors: \*Benthos, \*Macroinvertebrates, \*Piscicides, \*Rotenone, \*Species composition, \*Stream ecology, \*Mayflies, \*Population density, \*Population dynamics, \*Stoneflies.

Standing stocks and drift of macroinvertebrates from reaches treated with rotenone piscicide were compared with untreated reaches of two low-altitude streams within the Sepik-Ramu River drainage, Papua New Guinea. Total macrobenthic population densities were similar in both streams, although community composition showed significant inter-stream differences. In addition, certain lotic taxa (e.g. Plecoptera) characteristic of the Asian mainland were absent while others (e.g. naucorid bugs) had diversified in their absence. Rotenone induced immediate catastrophic drift: total drift densities peaked after 30 minutes and declined subsequently, showing similar trends in both streams. Taxa varied with respect to both the degree and timing of their response to rotenone, but Baetidae

(Ephemeroptera) were rapidly affected and were the most numerous drifting taxa. Certain baetid mayflies declined in abundance in rotenone-treated reaches, although not all morphospecies were affected equally. Standing stocks of leptophlebid mayflies, by contrast, were unaffected by rotenone application and total invertebrate standing stocks in both streams were unchanged. Overall, rotenone induced catastrophic drift but did not cause large-scale mortality and declines in benthic invertebrate abundance. (Author's abstract) W91-01767

**STUDIES ON THE CHEMISTRY OF INTERSTITIAL WATER TAKEN FROM DEFINED HORIZONS IN THE FINE SEDIMENTS OF BIVALVE HABITATS IN SEVERAL NORTHERN GERMAN LOWLAND WATERS: I. SAMPLING TECHNIQUES.**  
Tierärztliche Hochschule Hannover (Germany, F.R.). Inst. fuer Zoologie.  
V. Buddensiek, H. Engel, S. Fleischauer-Roessing, S. Olbrich, and K. Waechter.  
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 1, p 55-64, July 1990. 25 ref.

Descriptors: \*Fluvial sediments, \*Germany, \*Interstitial water, \*Lake sediments, \*Mussels, \*Sampling, \*Stream biota, \*Aquatic habitats, \*Endangered species, \*Hydrologic data collections, \*Mollusks.

In the course of sediment studies of freshwater bivalve habitats, a sampling technique for interstitial water, as originally described for rocky beds of running waters by Huisman in 1971 was modified for long term use in sand and gravel sediments of both running and standing lowland waters. The mobile unit allows sampling of 100 ml of interstitial water by means of a safety pipette filler or hand vacuum pump. A partial vacuum is built up in a suction flask connected to one tube of a sampling bottle. The second tube from this bottle leads to the stationary unit to which it is fitted by suitable plastic couplings, so that samples from defined levels can be drawn, after the water standing in the tubes has been discarded. O<sub>2</sub>-content, conductivity and pH are determined immediately in the sampling bottle. For the laboratory determination of NH<sub>4</sub>(+), NO<sub>3</sub>(-), and PO<sub>4</sub>(3-) samples were chloroform-fixed in the field and then either processed immediately or stored frozen at -20 °C until use. The stationary unit allows sampling from defined depths. Interstitial water was taken from 0, 1, 2, 3, 4, 5, 7, 9, 15, 20, 30, and 35 cm sediment depth in a German lowland stream with a population of *Unio crassus*, a German lowland stream with a *Margaritifera margaritifera* population, and a lake in the German lowlands with populations of *Unio pictorum* and *Unio tumidus*. In running waters some additional levels above 0 had to be sampled to adapt the sampling levels to possible variation of the sediment surface by drifting sand or organic debris. Results of these long-term studies provided data on O<sub>2</sub>, NH<sub>4</sub>(+), NO<sub>3</sub>(-), PO<sub>4</sub>(3-), pH and conductivity levels in the sediments at various depths and horizon specific seasonal changes in the concentration of several parameters that might affect survival of endangered mussel species in these microhabitats. (Geiger-PTT) W91-01768

**DECREASING CHLORIDE TRENDS OBSERVED AT LAKE ERIE MUNICIPAL WATER INTAKES.**

Lake County Dept. of Health, Waukegan, IL.  
For primary bibliographic entry see Field 5G. W91-01793

**EXPERIMENTAL USE OF DIALYSIS CHAMBER ARRAYS TO STUDY P-FLUXES IN THE BAY OF QUINTE, 1987.**

National Water Research Inst., Burlington (Ontario).  
P. G. Sly.  
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 258-270, 1990. 4 tab, 18 fig, 14 ref.

Descriptors: \*Bay of Quinte, \*Cycling nutrients, \*Dialysis, \*Lake Ontario, \*Phosphorus, \*Pollution load, \*Sediment contamination, \*Sediment-water

interfaces, \*Water analysis, \*Water pollution control, \*Analytical techniques, \*Experimental data, \*Nitrogen compounds, \*Organic carbon, \*Sediment analysis.

Dialysis chamber arrays were used to estimate proportions of the internal phosphorus load derived from degradation of fresh particulates at or near the base of the water column and partly aged bed material in the Bay of Quinte, Lake Ontario. Phosphorus released from partly aged lake bed sediment provided about 20% of the internal load at Hay Bay but the bed acted as sink for much of the time at Picton. At Hay Bay, sediment oxygen consumption rates were high averaging more than 0.6 gO<sub>2</sub>/sq m/d. Higher oxygen consumption rates characterized Picton sediments during the late summer and early fall and these were accompanied by a slight increase in the rate of phosphorus release. Combined mean P-reflux values derived from these experiments were higher than expected from model predictions based on past Bay of Quinte studies. The higher values may be caused by very rapid degradation of trapped material in the up-facing tubes due to the presence of excessive numbers of benthic invertebrates. (Author's abstract) W91-01796

**ESTIMATING THE VARIATION OF BUOY WIND AND WAVE DATA BIASES.**

Atmospheric Environment Service, Downsview (Ontario).  
S. Clodman.

Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 288-298, 1990. 5 tab, 4 fig, 8 ref.

Descriptors: \*Buoys, \*Calibrations, \*Data acquisition, \*Data analysis, \*Error analysis, \*Great Lakes, \*Instrumentation, \*Wind waves, \*Model studies, \*Statistical analysis, \*Variability, \*Waves, \*Wind velocity.

The bias variations of the U. S. National Data Buoy Center buoys located on the Great Lakes were quantitatively estimated by statistical comparisons of wind, speed, wave height and wave period. This was done by direct comparison and by using a wave model to estimate the wave parameters from the wind. The data seem to be consistent for any given station and year. Wave height and period biases remain constant but the wind speed bias does vary up to about plus or minus 15%. The wind speed bias is probably affected by changes in buoy instrumentation. These bias variations can be routinely estimated. The approach allows calibration information to be found from the actual data, replacing or improving calibrations done before or after the data period. (Miller-PTT) W91-01797

**INORGANIC CONTAMINANTS IN SUSPENDED SOLIDS FROM HAMILTON HARBOUR.**

National Water Research Inst., Burlington (Ontario). Lakes Research Branch.  
For primary bibliographic entry see Field 5B. W91-01798

**PLANKTONIC PROTOZOA IN LAKES HURON AND MICHIGAN: SEASONAL ABUNDANCE AND COMPOSITION OF CILIATES AND DINOFAGELLATES.**

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.

H. J. Carrick, and G. L. Fahnenstiel.  
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 319-329, 1990. 3 tab, 3 fig, 64 ref.

Descriptors: \*Dinoflagellates, \*Lake Huron, \*Lake Michigan, \*Limnology, \*Protozoa, \*Biomass, \*Ecosystems, \*Population density, \*Seasonal variation.

The abundance and biomass of surface and deep ciliate and dinoflagellate protozoa in the offshore waters of Lakes Huron and Michigan were determined from December 1986 to November 1987. Protozoan abundance (4 to 15 cells/mL) and biomass (13-140 microg/L) were comparable between

lakes and similar to those reported from other oligotrophic environments. Ciliates comprised the majority of protozoan abundance (80%) and biomass (73%). The mean size of these communities was small (20.6 microm) due to the numerical dominance of small ciliates, oligotrichs, and species of *Gymnodinium*. Total biomass in both lakes peaked during late June-July and again during October-November. These seasonal changes in biomass were accompanied by species replacements. Deep and surface communities were comparable in terms of abundance and biomass of ciliates, although deep community biomass decreased as stratification intensified. Because the biomass of ciliates alone represents about 30% of crustacean zooplankton biomass, protozoa may be more important grazers than once thought. (Author's abstract)  
W91-01799

#### EFFECTS OF VARIOUS BIOPHYSICO-CHEMICAL CONDITIONS ON TOXIGENICITY OF *VIBRIO CHOLERAE* 01 DURING SURVIVAL WITH A GREEN ALGA, *RHIZOCLONIUM FONTANUM*, IN AN ARTIFICIAL AQUATIC ENVIRONMENT.

London School of Hygiene and Tropical Medicine (England). Dept. of Tropical Hygiene.  
M. S. Islam.

Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 7, p 464-468, July 1990. 1 fig, 5 tab, 26 ref.

Descriptors: \*Algae, \*Aquatic environment, \*Bacterial toxins, \*Pathogenic bacteria, \*Survival, \*Toxicity, \*Toxins, \*Vibrio, \*Competition, \*Fate of pollutants, \*Hydrogen ion concentration, \*Light intensity, \*Rhizoclonium, \*Temperature effects, \*Tissue analysis.

Toxigenic and nontoxigenic strains of *Vibrio cholerae* 01 occur in the natural aquatic environment. It is not clear whether *V. cholerae* 01 lose toxigenicity and become nontoxigenic during survival in the aquatic environment as a result of the effect of various biophysicochemical conditions (e.g., sunlight, pH, temperature, competition with other bacteria for nutrients, etc.). Five toxigenic strains were exposed to artificial aquatic environments in the presence of a filamentous green alga, *Rhizoclonium fontanum*, and recovered after different time intervals (0 and 0.5 h, 3, 6, 9, and 15 days). This experimental system was exposed to sunlight and the *V. cholerae* 01 were in competition for nutrients with resident bacterial flora from *R. fontanum*. The toxigenicity of *Vibrio cholerae* 01 that were recovered at different time intervals was assessed by tissue culture assay using Vero cells. The toxigenicity of recovered strains was compared with that of the parent strains. The results demonstrated the toxigenic *V. cholerae* 01 are unlikely to lose their toxigenicity in aquatic environments as a result of the effects of various biophysicochemical conditions. These results are consistent with the hypothesis of environmental reservoirs of *V. cholerae*. (Author's abstract)  
W91-01801

#### SELENIUM AS A NUTRIENT FOR FRESHWATER BACTERIOPLANKTON AND ITS INTERACTIONS WITH PHOSPHORUS.

Uppsala Univ. (Sweden). Limnologiska Institutionen.  
C. Eriksson, and C. Pedros-Alio.

Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 7, p 475-483, July 1990. 6 fig, 1 tab, 40 ref.

Descriptors: \*Bacteria, \*Eutrophic lakes, \*Lakes, \*Nutrient concentrations, \*Oligotrophic lakes, \*Phosphorus, \*Plankton, \*Selenium, \*Sulfates, \*Bacterioplankton, \*Hyper-eutrophic lakes, \*Lake Banyoles, \*Lake Erken, \*Lake Vallentunajon, \*Limnology, Spain, Sweden.

The influence of selenite on the growth of bacterioplankton present in samples of three lakes was analyzed; these samples were collected in sulfate-rich, oligotrophic Lake Banyoles, moderately eutrophic Lake Erken, and hyper-eutrophic Lake Vallentunajon. The addition of P to samples from lakes Banyoles and Erken enhanced cell yields. Strong effects of phosphate on growth rates were

found in samples from lakes Banyoles and Vallentunajon. Selenite had a significant positive effect on cell yield on samples from lakes Banyoles and Vallentunajon, whereas the effect on cell yield in samples from Lake Erken was slightly negative. The addition of the selenite alone to samples from Lake Banyoles doubled the biovolume of bacterioplankton within 37 h during the spring. Among winter bacteria from Lake Banyoles, selenite increased the number of bacteria, but only when the phosphate level was high. A high inorganic phosphorus level was also necessary to stimulate the effect of selenite on bacterial growth in samples from Lake Vallentunajon. The negative effect of selenite on samples from Lake Erken was most obvious when phosphate had been added simultaneously. Cell yields were always greater at the highest temperatures. (Author's abstract)  
W91-01802

#### EFFECTS OF ACIDIFICATION ON LEAF DECOMPOSITION IN STREAMS.

Oak Ridge National Lab., TN. Environmental Sciences Div.

For primary bibliographic entry see Field 5C.

W91-01803

#### INTERSTITIAL DISSOLVED ORGANIC CARBON IN SEDIMENTS OF A SOUTHERN APPALACHIAN HEADWATER STREAM.

Georgia Univ., Athens. Dept. of Zoology.

M. T. Crocker, and J. L. Meyer.

Journal of the North American Benthological Society JNASEC, Vol. 6, No. 3, p 159-167, September 1987. 2 fig, 3 tab, 31 ref. NSF Grant No. BSR-85-14328.

Descriptors: \*Biomass, \*Decomposition, \*Dialysis, \*Dissolved organic carbon, \*Interstitial water, \*Limnology, \*Organic matter, \*Seasonal variation, \*Streams, \*Bacterial productivity, \*Benthic environment, \*Chemical analysis, \*Hyporheos, \*Sampling, \*Spatial distribution.

This study had two objectives: (1) to compare seasonal and spatial patterns of water-column dissolved organic carbon (DOC) and sediment interstitial DOC (IDOC) concentrations at a headwater spring seep, and (2) to explore interactions between sediment organic matter content, benthic bacterial biomass and production, water column DOC concentrations, and sediment IDOC concentration and composition (high versus low molecular weight components). For the first objective, sediment organic matter content, IDOC concentration (sampled from small wells by dialysis or by pipet), water column DOC concentration, and benthic bacterial biomass were measured at a spring seep in Coveata Hydrologic Laboratory, Macon Co. North Carolina USA, for two years. For the second objective, organic matter content was increased or decreased in experimental sediments. The same variables listed above were measured within three weeks of sediment manipulation and again after five and a half months. Benthic bacterial production was measured one week after sediment manipulation. Results indicate benthic organic matter is a source of IDOC, the concentration of which depends on sediment organic matter content, the relative proportion of high and low molecular weight IDOC compounds, and the exchange of interstitial and water column DOC. High molecular weight IDOC (>50,000) concentrations are lower than high molecular weight IDOC concentrations and are independent of sediment organic matter content. However, low molecular weight IDOC concentrations are generally greater than water column total DOC concentrations. Low molecular weight IDOC concentrations are greater during the dominant season than during the growing season. (Author's abstract)  
W91-01804

#### DISTRIBUTION AND PRIMARY PRODUCTIVITY OF THE EPIZOIC MACROALGA *BOLDIA ERYTHROSIPHON* (RHODOPHYTA) IN A SMALL ALABAMA STREAM.

Alabama Univ., University. Aquatic Biology Program.

M. S. Stock, T. D. Richardson, and A. K. Ward.

Journal of the North American Benthological Society JNASEC, Vol. 6, No. 3, p 168-174, September 1987. 3 fig, 2 tab, 20 ref.

Descriptors: \*Algae, \*Algal growth, \*Epizoaic algae, \*Limnology, \*Primary productivity, \*Rhodophyta, \*Seasonal variation, \*Snails, \*Streams, \*Animal behavior, \*Autochthonous carbon, \*Biological samples, \*Bolidia, \*Gastropods, \*Sampling, \*Spatial distribution.

The contribution of autochthonous carbon to a small stream by the epizoaic red macroalga *Boldia erythrosiphon* was determined from December 1985 through April 1986 in Little Schultz Creek, Alabama. *Boldia* grew almost exclusively on the snail species *Elmisa clara* and *E. cahawbensis*. A mean of 323 snails/sq m was found in the stream, 49% of which had the alga attached. *Elmisa clara* was nearly four times as abundant as *E. cahawbensis* and *Boldia* was significantly more associated with the former than with the latter snail. The differential distribution of the alga may be due to behavioral differences, *E. clara* preferring erosional sites with higher current rather than depositional sites. *Boldia* on snails contributed a mean of 37 mg C/sq m/d from January through April 1986 and a total of nearly 2 g C/sq m for the season. The latter value is one third of the seasonal primary production of epilithic algae on cobble measured in a previous study, and, when added to it, changes the annual pattern of autochthonous production in this stream. The productivity of the macroalga illustrates the importance of animals in providing substrata for algae in streams. In addition, to the presence of snails, a combination of factors including total light input, the chemical nature of substrata, differential grazing pressure, and substratum availability may affect colonization and growth of *Boldia*. (Author's abstract)  
W91-01805

#### EFFECTS OF HERBIVORE TYPE AND DENSITY ON TAXONOMIC STRUCTURE AND PHYSIOGNOMY OF ALGAL ASSEMBLAGES IN LABORATORY STREAMS.

Oregon State Univ., Corvallis. Dept. of Botany and Plant Pathology.

A. D. Steinman, C. D. McIntire, S. V. Gregory, G. A. Lamberti, and L. R. Ashkenas.

Journal of the North American Benthological Society JNASEC, Vol. 6, No. 3, p 175-188, September 1987. 24 fig, 3 tab, 45 ref. NSF Grant Nr. BSR-8318386.

Descriptors: \*Algae, \*Algal growth, \*Algal morphology, \*Biomass, \*Caddisflies, \*Diatoms, \*Grazing, \*Laboratory equipment, \*Laboratory methods, \*Limnology, \*Lotic environment, \*Snails, \*Taxonomy, \*Aquatic insects, \*Gastropods, \*Laboratory streams.

Four densities of a snail (*Juga silicula*) and a caddisfly (*Dicosmoecus gilvipes*) were introduced into separate laboratory streams, and their effects on algal biomass and community structure were monitored for 32 d. Tiles in an ungrazed control stream were covered by thick algal mats by day 32, and were composed primarily of *Scenedesmus* spp., *Characium*, and a variety of diatoms. Biomass and community structure of algal assemblages in the stream with the lowest density of snails were very similar to those in the control stream. In the other streams with snails, an inverse relationship developed between algal biomass and snail density after day 16. By day 32, the algal assemblages in the streams with high snail densities were dominated by adnate diatoms (e.g., *Achnanthes lanceolata*), and basal cells and short filaments of *Stigeoclonium* tenue. In contrast to the streams with snails, algal biomass was relatively low in all streams with caddisflies. The differences in algal biomass and structure between the streams with the lowest and highest densities of caddisflies were much smaller than those between streams with the lowest and highest densities of snails. On day 32, the taxonomic and physiognomic structure of the algal assemblages in all the streams with caddisflies resembled that in the streams with higher densities of snails. Scanning electron micrographs showed that even at the highest densities, neither snails nor caddis-

## Field 2—WATER CYCLE

### Group 2H—Lakes

flies could completely remove the algal assemblage. It is concluded that grazing can substantially influence algal growth form and assemblage physiognomy in lotic ecosystems. (See also W91-01807) (Author's abstract) W91-01806

#### EFFECTS OF HERBIVORE TYPE AND DENSITY ON CHEMICAL COMPOSITION OF ALGAL ASSEMBLAGES IN LABORATORY STREAMS

Oregon State Univ., Corvallis. Dept. of Botany and Plant Pathology.  
A. D. Steinman, C. D. McIntire, and R. R. Lowry. *Journal of the North American Benthological Society* JNASEC, Vol. 6, No. 3, p 189-197, September 1987. 5 tab, 34 ref. NSF Grant Nr. BSR-8318386.

Descriptors: \*Algae, \*Amino acids, \*Biochemistry, \*Biomass, \*Caddisflies, \*Fatty acids, \*Laboratory equipment, \*Laboratory methods, \*Lotic environment, \*Snails, Algal growth, Aquatic insects, Chemical composition, Gastropods, Grazing, Laboratory streams.

The chemical composition of algal assemblages in laboratory streams was determined 3 and 27 d after adding snail (*Juga silicula*) and larval caddisfly (*Dicosmoecus glivipes*) grazers. Three days after the herbivores were introduced (day 8 of algal growth), the fatty acid and amino acid profiles among algal assemblages were similar. Substantial differences were noted after 4 wk (day 32 of algal growth), however, especially with respect to the 16:0, 16:1, 16:3, 18:3, and 20:5 fatty acids. On day 32, algal assemblages subjected to zero or 125 snails/stream (66/sq m) had higher levels of glycine, leucine, isoleucine, tyrosine, and the 16: and 18:3 fatty acids than assemblages exposed to 500 snails/stream (250/sq m), 50 caddis/stream (25/sq m), or 200 caddis/stream (100/sq m). On the other hand, assemblages subjected to high grazing pressure (i.e., 500 snails/stream, 50 and 200 caddis/stream) had higher levels of alanine, glutamic acid, glutamine, and the 16:0, 16:1, and 20:5 fatty acids than algae exposed to zero or 125 snails/stream. These data provide detailed information on the food quality of lotic algae and may serve as a starting point for future research on this field. (See also W91-01806) (Author's abstract) W91-01807

#### EMPIRICAL EVIDENCE FOR DIFFERENCES AMONG METHODS FOR CALCULATING SECONDARY PRODUCTION

Montreal Univ. (Quebec). Dept. of Biological Sciences.  
For primary bibliographic entry see Field 7C. W91-01808

#### RATES OF PROTOZOAN BACTERIVORY IN THREE HABITATS OF A SOUTHEASTERN BLACKWATER RIVER

Georgia Univ., Sapelo Island. Marine Inst.  
L. A. Carlough, and J. L. Meyer. *Journal of the North American Benthological Society* JNASEC, Vol. 9, No. 1, p 45-53, March 1990. 2 fig, 3 tab, 50 ref. NSF Grant Nr. BSR-8705744.

Descriptors: \*Aquatic bacteria, \*Bacterivory, \*Flagellates, \*Food chains, \*Grazing, \*Limnology, \*Lotic environment, \*Microorganisms, \*Protozoa, \*Secondary productivity, Aquatic environment, Ciliates, Filter feeders, Fluorescent tracers, Particle size.

Although protozoa have been largely disregarded in the trophic structure of lotic systems, they have been shown to be important in lentic and marine environments. As part of a larger study concerning the basis of secondary production in the Ogeechee River, GA, preliminary experiments were done using fluorescently-labelled bacteria to directly measure bacterial grazing by protozoa. Protozoan grazing rates can be as high in moving lotic waters as in still waters as demonstrated by comparing a main channel site, a backwater, and a floodplain pond. In the main channel site during April and

May 1988, flagellates and ciliates ingested an average of 17 and 420 bacteria/individual/hr, respectively. When this is multiplied by the high protozoan densities present, an average of 47% of the water-column in the main channel is estimated to be cleared of bacteria by protists each day. Protozoan bacterivory could facilitate carbon flow to higher trophic levels by turning bacteria into larger parcels of carbon and nutrients which are available to a greater portion of the filter-feeding members of communities. (Author's abstract) W91-01809

#### TIMING OF WAVE DISTURBANCE AND THE RESISTANCE AND RECOVERY OF A FRESH-WATER EPILITHIC MICROALGAL COMMUNITY

Louisville Univ., KY. Dept. of Biology.  
C. G. Peterson, K. D. Hoagland, and R. J. Stevenson. *Journal of the North American Benthological Society* JNASEC, Vol. 9, No. 1, p 54-67, March 1990. 5 fig, 4 tab, 58 ref.

Descriptors: \*Algae, \*Algal growth, \*Algal populations, \*Chlorophyll a, \*Diatoms, \*Fragilaria, \*Limnology, \*Nitzschia, \*Oscillatoria, \*Periphyton, \*Phaeophyta, \*Wave action, \*Waves, Epilithic algae, Lake McConaughy.

Microalgal communities on clay tiles in Lake McConaughy (Nebraska, USA) were subjected to simulated wave disturbance after 6, 12, 18, or 24 d of development to examine the effects of community age on resistance and recovery in these communities. Six-day communities were less resistant than older communities; diatom standing crops in 6-d communities were reduced 47.6% by disturbance. Resistance of older communities was apparently a function of increased mat stabilization by diatom mucilages and overlying *Oscillatoria* surface layers. Diatom density reductions in 6-d communities were due to differential removal of large, chain-forming species of *Fragilaria*, and solitary, motile *Navicula* and *Nitzschia*. Sediment-trap data showed that *Fragilaria* and *Navicula* resettled quickly, but that once removed, many *Nitzschia* were not readily replaced through immigration. Differential removal of diatom taxa by disturbance at 6 d, as well as differential settling of taxa following disturbance affected community recovery patterns. Simulated wave disturbance also caused short-term increases in growth rates of four common taxa in 6-d communities. After 24 d, phaeophytin content of control communities exceeded chlorophyll a concentrations, indicating senescence of algal cells. Communities disturbed after 18 or 24 d had chlorophyll a concentrations similar to controls, but significantly lower phaeophytin content, suggesting that wave disturbance delayed senescence within algal mats. It was concluded that wave disturbance can affect resistance and recovery of epilithic algal communities in lentic systems and that timing of disturbance influences community response. (Author's abstract) W91-01810

#### PERSPECTIVE ON EL NINO AND LA NINA: GLOBAL IMPLICATIONS FOR STREAM ECOLOGY

New Mexico Univ., Albuquerque. Dept. of Biology.  
For primary bibliographic entry see Field 2B. W91-01811

#### VOLATILIZATION OF SELENIUM FROM AGRICULTURAL EVAPORATION POND SEDIMENTS

California Univ., Riverside. Dept. of Soil and Environmental Sciences.  
For primary bibliographic entry see Field 5G. W91-01814

#### INVERTEBRATE COMMUNITIES OF SMALL STREAMS IN NORTHEASTERN WYOMING

Geological Survey, Cheyenne, WY. Water Resources Div.  
D. A. Peterson.  
Available from Books and Open File Report Sec-

tion, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 85-4287, 1990. 45p, 17 fig, 1 tab, 32 ref. USGS Project No. WY057.

Descriptors: \*Invertebrates, \*Mine wastes, \*Powder River Basin, \*Water pollution effects, \*Wyoming, Aquatic habitats, Benthic fauna, Benthic flora, Ephemeral streams, Intermittent streams, Perennial streams.

Invertebrate communities of small streams in an energy-mineral-development area in the Powder River structural basin of northeastern Wyoming were studied during 1980-81. The largest average density of benthic invertebrates among 11 sites was 983 invertebrates/sq ft at a site on a perennial stream, the Little Powder River at State Highway 59. The smallest average densities were 3.4 invertebrates/sq ft in Salt Creek and 16.6 invertebrates/sq ft in the Cheyenne River, two streams where the invertebrates were stressed by degraded water quality or inadequate substrate or both. The rates of invertebrate drift were fastest in three perennial streams, compared to the rates in intermittent and ephemeral streams. Analysis of the invertebrate communities using the Jaccard coefficient of community similarity and a cluster diagram showed communities inhabiting perennial streams were similar to each other, because of the taxa adapted to flowing water in riffles and runs. Communities from sites on ephemeral streams were similar to each other, because of the taxa adapted to standing water and vegetation in pools. Communities of intermittent streams did not form a group; either they were relatively similar to those of perennial or ephemeral streams or they were relatively dissimilar to other communities. The communities of the two streams stressed by degraded water quality or inadequate substrate or both, Salt Creek and the Cheyenne River, were relatively dissimilar to communities of the other streams in the study. (USGS) W91-01850

#### SOLUTION-COLLAPSE DEPRESSIONS AND SUSPENSATES IN THE LIMNOCRENIC LAKE OF BANYOLES (NE SPAIN)

Barcelona Univ. (Spain).  
For primary bibliographic entry see Field 2J. W91-01876

#### REVISED ESTIMATE OF THE LIFE SPAN FOR LAKE NASSER

Florida Univ., Gainesville. Dept. of Civil Engineering.  
S. E. Smith.  
*Environmental Geology and Water Sciences* EGWSEI, Vol. 15, No. 2, p 123-129, March/April 1990. 5 fig, 2 tab, 11 ref.

Descriptors: \*Aswan High Dam, \*Lake Nasser, \*Lakes, \*Nile River, \*Reservoir silting, \*Sedimentation, Egypt, Forecasting, Hydrologic data collections, Hydrology, Mathematical studies, Reservoir operation, Sudan, Suspended sediments.

A number of estimates of the potential life span of Lake Nasser located in Egypt and Sudan have been made in the past several years. Published estimates range from as little as 20 years to over 1500 years. The wide range of differing values is a function of many variables, including computation method, input data, and theoretical assumptions underlying the mathematical approach taken. Such a broad range of values is typical of sedimentation studies performed for areas that lack an adequate historic data base. One of the chief constraints to development of a reliable estimate of Lake Nasser's case has been lack of sufficient historical data on which to construct a useful data base. Enough information of this type has been collected since the reservoir's formation in 1964 to permit a realistic assessment of its life span. Granted the obvious need to determine the useful lifetime of this or any other reservoir, it is now possible to assess the reliability of the current official estimate for Lake Nasser. By applying appropriate modifications and additional data to the official estimate, an improved estimate was made. The time forecasted for filling of the reservoir by the official estimate is

362 years, somewhat less than the original design life of 500 years. By taking into account changes in the hydrological regime of the Nile after 1964 and another compaction factor, an estimate of 335 years was made. The additional time before filling estimated in the revision is significant for decision rules governing operation of the Aswan High Dam. (Author's abstract)  
W91-01884

#### ACIDIFICATION IN NORWAY - LOSS OF FISH POPULATIONS AND THE 1000 LAKE SURVEY 1986.

Norsk Inst. for Vannforskning, Oslo.  
For primary bibliographic entry see Field 5C.  
W91-01889

#### NUTRIENT EXCHANGES BETWEEN THE WATER COLUMN AND A SUBTIDAL BENTHIC MICROALGAL COMMUNITY.

Virginia Inst. of Marine Science, Gloucester Point.  
W. M. Rizzo.  
Estuaries ESTUDO, Vol. 13, No. 3, p 219-226, September 1990. 5 fig, 29 ref.

Descriptors: \*Benthic environment, \*Estuaries, \*Estuarine environment, \*Nutrient transport, \*River sediments, Algae, Ammonium, Nitrates, Nitrites, Phosphates, Virginia, Water column, York River.

The exchange of nutrients between the shallow (ca. 1 m) sediments and the water column in the York River, Virginia, were measured during 1983 using transparent and opaque plexiglass hemispheres. The exchange of nitrates and phosphates were not significantly different between dome treatments, but ammonium release was significantly reduced within the transparent domes. Within the dark domes, ranges of hourly rates of ammonium and phosphate exchange were -21 to 364 N micromol/sq m and -3 to 76 micromol P/sq m, while those in the transparent domes were -162 to 244 and -6 to 80, respectively. Negative values denote uptake by the sediment. Nitrate + nitrite exchanges averaged only 15% of the total dissolved inorganic nitrogen exchange in the dark domes and 17% of the total dissolved inorganic nitrogen exchange in the transparent domes. (Author's abstract)  
W91-01897

#### BAROTROPIC, SUBTIDAL EXCHANGE BETWEEN CALCASIEU LAKE AND THE GULF OF MEXICO.

Louisiana State Univ., Baton Rouge. Dept. of Marine Science.  
J. M. Lee, W. J. Wiseman, and F. J. Kelly.  
Estuaries ESTUDO, Vol. 13, No. 3, p 258-264, September 1990. 6 fig, 3 tab, 13 ref.

Descriptors: \*Barotropic flow, \*Calcasieu Lake, \*Estuaries, \*Gulf of Mexico, \*Saline-freshwater interfaces, \*Wind tides, \*Wind-driven currents, Estuarine environment, Flow characteristics, Mathematical models, Model studies, Water level, Wind.

Long-term measurements of flow through Calcasieu Pass, Louisiana, are compared to water level variations within Calcasieu Lake, Louisiana. Except during periods of freshets driven by local rainfall, the exchange is shown to be predominantly barotropic. A simple wind driven model accounts for the observed phase relations between wind, current, and water level. Calcasieu Lake is a broad, shallow estuary characterized by minor freshwater runoff, moderate tidal energy, and, except in summer, strong wind stress events. This situation is conducive to barotropic subtidal exchanges with the coastal ocean on time scales of 3 to 10 d. These exchanges are important for the recruitment of larval fish to the estuarine nursery grounds, and may be adequately monitored without costly current meter deployments, using only tide gauge measurements. During low wind and high runoff events, stratification and a baroclinic flow regime may develop. These are times when water exchange with the shelf can not be predicted from tide gauge data. A simple linear wind-driven model of the barotropic exchange has been suc-

cessful in hindcasting the energy containing exchanges when cold fronts are the dominant synoptic weather pattern. The model assumes, without supportive data, that the coastal sea level rise is a significant fraction of that occurring within Calcasieu Lake. (Lantz-PTT)  
W91-01901

#### GROWTH OF SUBMERGED MACROPHYTES UNDER EXPERIMENTAL SALINITY AND LIGHT CONDITIONS.

University of Southwestern Louisiana, Lafayette. Dept. of Biology.  
R. R. Twilley, and J. W. Barko.  
Estuaries ESTUDO, Vol. 13, No. 3, p 311-321, September 1990. 8 fig, 1 tab, 48 ref.

Descriptors: \*Light intensity, \*Macrophytes, \*Salinity, Biomass, Chlorophyll a, Comparison studies, Estuaries, Nitrogen, Plant growth, Plant physiology, Sodium, Solar radiation, Tissue analysis.

The growth, morphology, and chemical composition of *Hydrilla verticillata*, *Myriophyllum spicatum*, *Potamogeton perfoliatus*, and *Vallisneria spiralis* americana were compared among different salinity and light conditions. Plants were grown in microcosms (1.2 cu m) under ambient photoperiods adjusted to 50% and 8% of solar radiation. The culture solution in 5 pairs of tanks was gradually adjusted to salinities of 0, 2, 4, 6 and 12‰. With the exception of *H. verticillata*, the aquatic macrophytes examined may be considered euryhaline species that are able to adapt to salinities one-third the strength of sea water. With increasing salinity, the inflorescence production decreased in *M. spicatum* and *P. perfoliatus*, yet asexual reproduction in the latter species by underground buds remained constant. Stem elongation increased in response to shading in *M. spicatum*, while shaded *P. perfoliatus* had higher concentrations of chlorophyll-a. In association with high epiphytic mass, chlorophyll-a concentrations in all species were greatest at 12‰. The concentration of sodium increased in all four species of aquatic macrophytes examined, indicating that these macrophytes did not possess mechanisms to exclude this ion. The nitrogen content (Y) of the aquatic macrophytes tested increased significantly with higher sodium concentration (X), suggesting that nitrogen may be utilized in osmoregulation ( $Y = X \times 0.288 + 6.10$ ,  $r^2 = 0.71$ ). The tolerance of *V. americana* and *P. perfoliatus* to salinity was greater in this study compared to other investigations. This may be associated with experimental methodology, whereby macrophytes were subjected to more gradual rather than abrupt changes in salinity. The two macrophytes best adapted to estuarine conditions in this study by exhibiting growth up to 12‰, included *M. spicatum* and *V. americana*, which also exhibited a greater degree of response in morphology, tissue chemistry (including chlorophyll content and total nitrogen), and reproductive output in response to varying salinity and light conditions. (Author's abstract)  
W91-01907

#### STABILITY OF PERIPHYTON AND MACROINVERTEBRATES TO DISTURBANCE BY FLASH FLOODS IN A DESERT STREAM.

Arizona State Univ., Tempe. Dept. of Zoology.  
N. B. Grimm, and S. G. Fisher.  
Journal of the North American Benthological Society JNASEC, Vol. 8, No. 4, p 293-307, December 1989. 7 fig, 2 tab, 63 ref. NSF grant BSR 84-06891.

Descriptors: \*Arizona, \*Deserts, \*Macroinvertebrates, \*Periphyton, \*River ecology, \*Streams, \*Succession, Flooding effects, Life cycles, Limiting nutrients, Nitrogen, Seasonal variation.

Resistance, resilience, and patterns of succession were evaluated for periphyton and macroinvertebrates of Sycamore Creek, Arizona, between 1984 and 1987. During this period, 35 flash-flood disturbances occurred, ranging in magnitude (peak discharge) from 0.2 meters cubed per second to 38 meters cubed per second; peak discharge of the largest flash floods exceeded base flow by 3-4 orders of magnitude. Macroinvertebrates and algal

assemblages dominated by diatoms were more resistant, i.e., showed less change in response to spates, than macroalgae (filamentous Chlorophyta) and cyanobacterial mats, but resistance of all groups declined with increasing disturbance magnitude. Biota showed little resistance to events large enough to move substrata. Twenty sequences of postflood succession were analyzed to characterize resilience and patterns of recovery. Resilience was very high compared with other streams and other ecosystems, because of high rates of biotic production in this desert stream. Resilience of periphyton (as indicated by recovery of total chlorophyll a) was highest in summer and autumn, while macroinvertebrate resilience (in terms of density or biomass) did not differ among seasons. In many sequences, recovery curves of macroinvertebrate and algal standing crops were linear or asymptotic; however, macroinvertebrates declined precipitously during later stages of five successional sequences, primarily because of declines in the dominant collector-gatherers. These organisms reproduce continuously and have short life cycles, so declines cannot be explained by synchronous emergence. Instead, declines may be caused by food quality limitation. Sustained high rates of macroinvertebrate consumption and use of autochthonous detritus are possible only if bacterial conditioning (and immobilization of nitrogen) can increase the N content of this material, which is halved with each gut passage. During many sequences, bacterial conditioning is probably limited by nitrogen, which is known to limit autotrophic processes in this stream. This suggests that productivity at higher trophic levels may be influenced by availability of a limiting nutrient not only to primary producers but to microconsumers. (Author's abstract)  
W91-01924

#### DISCHARGE-EXPORT RELATIONSHIPS IN HEADWATER STREAMS: THE INFLUENCE OF INVERTEBRATE MANIPULATIONS AND DROUGHT.

Georgia Univ., Athens. Dept. of Entomology.  
T. F. Cuffney, and J. B. Wallace.  
Journal of the North American Benthological Society JNASEC, Vol. 8, No. 4, p 331-341, December 1989. 6 fig, 4 tab, 28 ref. NSF grants BSR 83-16082 and BSR 87-18005.

Descriptors: \*Appalachian Mountains, \*Drought effects, \*Flow discharge, \*Invertebrates, \*Organic matter, \*Particulate matter, \*Streams, Drought, Headwaters, Insecticides, Methoxychlor.

The role of physical (discharge) and biological (macroinvertebrate communities) factors in the control of coarse (greater than 4 mm) and fine (less than or equal to 4 mm and greater than 0.5 micrometers) particulate organic matter (FPOM) transport was studied in three headwater streams of the southern Appalachian Mountains. The role of discharge was determined by relating two years of continuous measurements obtained over discrete (ca. 2-wk) time intervals. The role of macroinvertebrates was examined by treating one of the three streams, C 54, with an insecticide during Year 2 to reduce populations and alter community structure. Maximum discharge was the only discharge parameter which adequately predicted (linear regressions) FPOM export during a sampling interval ( $r^2$  squared  $> 0.70$ ). These regressions were unique for each stream and were constant between years for the untreated streams, despite a record drought during the second year. Relationships between discharge and export of coarse particulate organic matter (CPOM) were not as strong nor as consistent as those for FPOM. CPOM export was very sensitive to timing of CPOM inputs and storms (e.g., 78 to 88% of CPOM export during Year 2 occurred during a single fall storm). Consequently, CPOM export-discharge relationships differed not only among streams but also between years and did not show treatment effects. Treating C 54 with methoxychlor during Year 2 resulted in massive invertebrate drift and drastically reduced populations of macroinvertebrates, practically eliminating shredders and collector-filterers. Maximum discharge continued to be a good predictor of FPOM export ( $r^2$  squared = 0.83) for C 54

## Field 2—WATER CYCLE

### Group 2H—Lakes

during the treatment year, but the yield of export per unit of maximum discharge (slope of the discharge-FPOM export regression) decreased by 65%. This contrasts with the untreated streams in which the slopes were constant between years despite the greater than 50 year drought during Year 2. Most (75%) of the decrease in FPOM yields from C 54 is directly attributable to the reduction in macroinvertebrates. Only 25% is attributable to the drought even though stream flows dropped by ca. 40% during Year 2. (Author's abstract)  
W91-01925

**SPATIAL AND TEMPORAL DISPERSION PATTERNS OF GOLDEN PERCH, MACQUARIA AMBIGUA, LARVAE IN AN ARTIFICIAL FLOODPLAIN ENVIRONMENT.**  
New South Wales Dept. of Agriculture, Narrandera (Australia). Inland Fisheries Station.  
P. C. Gehrke.  
Journal of Fish Biology JFIB9, Vol. 37, No. 2, p 225-236, August 1990. 5 fig, 6 tab, 25 ref.

Descriptors: \*Fish, \*Flood plains, \*Perch, \*Ponds, \*Spatial distribution, \*Temporal distribution, Aquatic habitats, Fish stocking, Larvae, Thermal stratification, Water quality.

Golden perch larvae were stocked into a pond and inundated floodplain system in south-eastern Australia to determine movement patterns of the larvae onto and off the floodplain area. A total of 428 larvae were caught moving from the floodplain into the pond whereas only 18 were collected moving in the reverse direction. Thirty one larvae were caught at open water sites in the pond and floodplain, but only three were collected from sites on the floodplain which provided shade, timber or water flow. Transect samples from the pond also yielded more larvae than samples from floodplain transects, indicating a distinct spatial dispersion pattern in favor of the pond. Spatial dispersion patterns of golden perch larvae appear to correspond with gradients in water quality between the pond and floodplain habitats. Stratification occurred in the pond but did not develop on the floodplain. Water on the floodplain was cooler, harder and contained less oxygen than surface water from the pond. Diel oscillations occurred in water temperature, pH, dissolved oxygen, carbon dioxide and acidity, but there was no significant corresponding pattern in the distribution of larvae. Dispersion of golden perch larvae between pond and floodplain habitats is not random, and may be actively influenced by local-scale variations in water quality. (Author's abstract)  
W91-01957

**ECOLOGICAL MECHANISMS IMPORTANT FOR THE BIOTIC CHANGES IN ACIDIFIED LAKES IN SCANDINAVIA.**  
Goeteborg Univ. (Sweden). Dept. of Zoology.  
For primary bibliographic entry see Field 5C.  
W91-02015

**PHYSIOLOGICAL RESPONSES TO SEVERE ACID STRESS IN FOUR SPECIES OF FRESHWATER CLAMS (UNIONIDAE).**  
Helsinki Univ. (Finland). Dept. of Zoology.  
For primary bibliographic entry see Field 5C.  
W91-02026

**BIOACCUMULATION OF SELENIUM IN BIRDS AT KESTERSON RESERVOIR, CALIFORNIA.**  
Patuxent Wildlife Research Center, Davis, CA.  
Pacific Coast Field Station.  
For primary bibliographic entry see Field 5C.  
W91-02029

**HEAT CONTENTS, THERMAL STABILITIES AND BIRGEAN WIND WORK IN DYSTROPHIC TASMANIAN LAKES AND RESERVOIRS.**  
University of New England, Armidale (Australia).  
Dept. of Botany.  
L. C. Bowling.  
Australian Journal of Marine and Freshwater Res-

search AJMFA4, Vol. 41, No. 3, p 429-441, 1990. 5 fig, 3 tab, 23 ref.

Descriptors: \*Dystrophic lakes, \*Enthalpy, \*Limnology, \*Reservoirs, \*Tasmania, \*Thermal stratification, \*Wind effects, Energy cycle, Heat budget, Mixing.

Values of whole-lake standard energy parameters (heat content, thermal stability, and Birge's work of the wind) for ten dystrophic standing waters from western Tasmania were lower than expected for lakes of their depth and area. Although controlled principally by morphometric factors, the degree of shelter from wind and the extent of each lake's dystrophy also had considerable effects. These factors allowed only surface waters to contribute to the annual heat exchange cycle, thereby reducing the magnitude of each lake's heat budgets and influencing stability and wind work values. The lakes show considerable short term and long term fluctuations in heat content, stability and wind work in response to the capricious maritime meteorological conditions of the area. However, long periods between successive sampling may have caused some underestimation of the ranges of these three parameters. Despite this, the study reveals that these standard energy parameters are effective in describing the annual energy input and resistance to wind-induced mixing of these dystrophic Tasmanian lakes. (Author's abstract)  
W91-02043

## 2I. Water In Plants

**PHYSIOLOGICAL RESPONSE OF YELLOW-POPLAR SEEDLINGS TO SIMULATED ACID RAIN, OZONE FUMIGATION, AND DROUGHT.**  
Agricultural Research Service, Delaware, OH.  
For primary bibliographic entry see Field 5C.  
W91-01068

**EVAPOTRANSPIRATION, WATER USE EFFICIENCY, MOISTURE EXTRACTION PATTERN AND PLANT WATER RELATIONS OF RAPE (BRASSICA CAMPESTRIS) GENOTYPES IN RELATION TO ROOT DEVELOPMENT UNDER VARYING IRRIGATION SCHEDULES.**  
Haryana Agricultural Univ., Hissar (India).  
For primary bibliographic entry see Field 2D.  
W91-01114

**CLIMATE AND VEGETATION IN CHINA. III. WATER BALANCE AND DISTRIBUTION OF VEGETATION.**  
Osaka Univ. (Japan). Faculty of Science.  
J. Y. Fang, and K. Yoda.  
Ecological Research (Kyoto) ECRSEX, Vol. 5, No. 1, p 9-23, April 1990. 7 fig, 5 tab, 49 ref.

Descriptors: \*China, \*Climatology, \*Moisture profiles, \*Soil-water-plant relationships, \*Vegetation effects, \*Water budget, Coniferous forests, Deciduous forests, Deserts, Evapotranspiration, Steppes.

Distributions of 29 vegetation types in China as a function of climatic humidity or aridity were analyzed using Thornthwaite's system, by employing meteorological records from 671 stations in China. The annual potential evapotranspiration and the humidity/aridity indices were calculated for every station, and distribution maps of water deficiency, water surplus and moisture index (Im) were constructed. The Im map showed that arid areas (Im < 0) occupied about 56% of the country. The effect of the difference in soil water storage capacity on Thornthwaite's indices was examined, and Im values were found to differ little, although some differences were observed in actual annual evapotranspiration, water deficiency and water surplus values. Correlations between Im values and distributions of 29 vegetation types, identified from a vegetation map with a scale of 1/4,000,000, were investigated. The distributions of desert, steppe, woodland, deciduous forest and evergreen forest corresponded to Im values of below -40, -40 to -20, -20 to 0, 0 to 60 and over 60, respectively. In

addition, climatic factors delimiting the northern distribution of evergreen broadleaf forest were investigated, and it was clarified that the northern limit was restricted by combined hydrothermal conditions, and not by the low temperature in winter. (Author's abstract)  
W91-01125

**NUTRIENT DYNAMICS IN A FLOATING MAT AND POND SYSTEM WITH SPECIAL REFERENCE TO ITS VEGETATION.**  
Kyoto Univ. (Japan). Lab. for Plant Ecological Studies.  
For primary bibliographic entry see Field 2H.  
W91-01126

**EFFECTS OF SALINE WATER IRRIGATION ON GROWTH AND MINERAL DISTRIBUTION IN GUAR (CYAMOPSIS TETRAGONOLoba (L.) TAUB).**  
Karachi Univ. (Pakistan). Dept. of Botany.  
For primary bibliographic entry see Field 3C.  
W91-01149

**CANOPY TEMPERATURE AS AN INDICATOR OF DIFFERENTIAL WATER USE AND YIELD PERFORMANCE AMONG WHEAT CULTIVARS.**  
Agricultural Research Service, Phoenix, AZ.  
Water Conservation Lab.  
For primary bibliographic entry see Field 3F.  
W91-01407

**DYNAMICS OF ROOT AND SHOOT GROWTH OF BARLEY UNDER VARIOUS LEVELS OF SALINITY AND WATER STRESS.**  
Agriculture and Water Resources Research Centre, Baghdad (Iraq). Dept. of Soil and Land Reclamation.  
For primary bibliographic entry see Field 3F.  
W91-01409

**CLIMATIC CONTROL OF VEGETATION DISTRIBUTION: THE ROLE OF THE WATER BALANCE.**  
Cornell Univ., Ithaca, NY. Section of Ecology and Systematics.  
For primary bibliographic entry see Field 2B.  
W91-01684

**HEAT STRESS, PLANT-AVAILABLE SOIL MOISTURE, AND CORN YIELDS IN IOWA: A SHORT- AND LONG-TERM VIEW.**  
Iowa State Univ., Ames. Dept. of Agronomy.  
For primary bibliographic entry see Field 3F.  
W91-01703

**CLIPPING DATE EFFECTS ON SOIL WATER AND REGROWTH IN CRESTED WHEAT-GRASS.**  
Oregon State Univ., Union. Eastern Oregon Agricultural Research Center.  
For primary bibliographic entry see Field 2G.  
W91-01706

**EFFECT OF SOIL WATER, NITROGEN, AND GROWING DEGREE-DAYS ON MORPHOLOGICAL DEVELOPMENT OF CRESTED AND WESTERN WHEAT-GRASS.**  
Agricultural Research Service, Mandan, ND.  
Northern Great Plains Research Center.  
A. B. Frank, and R. E. Ries.  
Journal of Range Management JRMGAQ, Vol. 43, No. 3, p 257-260, May 1990. 2 fig, 4 tab, 14 ref.

Descriptors: \*Grasses, \*Nitrogen, \*Soil chemistry, \*Soil water, \*Soil-water-plant relationships, \*Wheat, Morphology, Plant growth, Vegetation.

Production of total forage dry matter is mainly a function of available soil water and soil nitrogen (N), whereas plant morphological development from spring greenup to anthesis is primarily controlled by air temperature. There is a lack of

information on the effects of soil water and soil N on plant morphological development. A study was conducted in a rain-out shelter at Mandan, North Dakota, over a three year period to determine the effect of 2 fertilizer N rates (11 and 110 kg N/ha) and three rates of applied water (50, 100, and 150% of long-term April-November rainfall at Mandan, North Dakota) on the morphological development of initial spring growth and fall regrowth of crested wheatgrass (*Agropyron desertorum*) and western wheatgrass (*Pascopyrum smithii*). Regression analysis of plant development stage with accumulated growing degree days (GDD) was linear for both initial and regrowth forage. There were no differences in the rate of plant development for the three rates of applied water or the 2 rates of N fertilizer. Initial growth forage of crested and western wheatgrass required 82 and 98 GDD to produce a leaf, respectively. Regrowth forage of crested wheatgrass required 372 and western wheatgrass 135 more GDD than initial growth to produce a leaf. These data confirm that plants develop primarily in response to air temperature and not added water or N, which enhances the utility of using the accumulation of GDD for predicting development of crested and western wheatgrass under different growing conditions. This information can be useful for predicting plant development of these species in growth models, and for farmers and ranchers in predicting grazing readiness. (Author's abstract)  
W91-01707

#### INFLUENCE OF ORGANIC SEDIMENT AMENDMENTS ON GROWTH AND TUBER PRODUCTION BY POTAMOGETON PECTINATUS L.

Agricultural Research Service, Davis, CA. Aquatic Weed Control Research Lab.  
D. F. Spencer.  
Journal of Freshwater Ecology JFREDW, Vol. 5, No. 3, p 255-263, June 1990. 3 fig, 2 tab, 19 ref.

Descriptors: \*Aquatic plants, \*Aquatic soils, \*Plant growth, \*Sago pondweed, \*Sediments, \*Soil amendments, \*Soil-water-plant relationships, Macrophytes, Nutrients, Organic compounds, Organic matter, Peat, Sugars.

Results from experiments with *Potamogeton pectinatus* L. grown in an artificial substrate amended with various combinations of peat and glucose or sucrose suggest that plant weight and the number of tubers produced per plant increased significantly when plants were grown in sediment amended with peat. Contrary to expectations, the addition of labile organic components, glucose or sucrose, to the substrate (up to 15%, w/w) did not influence plant growth. Plants grown in sediment amended with peat had higher levels of tissue Fe. The weight of tubers produced per gram of non tuber tissue was not influenced by sediment properties. These results support the hypothesis that the mechanism by which sediment organic matter affects macrophyte growth is by altering sediment density. (Author's abstract)  
W91-01740

#### STRENGTH OF SCLEROPHYLLOUS CELLS TO RESIST COLLAPSE DUE TO NEGATIVE TURGOR PRESSURE.

Eidgenössische Technische Hochschule, Zurich (Switzerland). Inst. of Plant Sciences.  
J. J. Oertli, S. H. Lips, and M. Agami.  
Acta Oecologica, Vol. 11, No. 2, p 281-289, 1990. 2 fig, 1 tab, 19 ref.

Descriptors: \*Desert plants, \*Drought, \*Drought resistance, \*Moisture deficiency, \*Plant physiology, \*Plant tissues, \*Plant water potential, \*Turgidity, \*Water stress, \*Adaptation, \*Cytology, \*Cytorrhy- sis, \*Hydrostatic pressure, \*Plant growth, \*Plant morphology, \*Plant populations, \*Sclerophylly.

When the hydrostatic pressure within the protoplast drops below 1 bar (0.1 MPa), i.e., when the turgor pressure becomes negative while the external pressure is atmospheric at one bar, the plant cell is exposed to a compressive stress and will collapse if the stress is sufficiently great. A method is described to measure the strength of cell walls to

resist such a collapse. Pressure differences of much less than 0.1 MPa suffice to cause collapse of cells in mesophyllous tissues. In contrast, some Mediterranean and desert plants contain cells with thickened walls that exhibit considerable resistance to collapse. Smaller cells, as are often observed under drought also improve the resistance to collapse. Ephemeral desert plants or organs again show mesophyllous tissues with only nominal resistance. The hypothesis is forwarded that sclerophylly is a mechanism of adaptation to drought if a sufficient quantity of water is available to the plant to survive year round. This is the case for Mediterranean shrubs and trees growing in the desert along ground water courses where the available water is increased by an influx of water from other areas. Desert plants that have to rely solely on local precipitation show a phenological adaptation with mesophyllous tissues. (Author's abstract)  
W91-01800

#### NEW GENE SOURCES FOR DEVELOPMENT OF AGRONOMIC PLANTS WITH TOLERANCE TO DROUGHT AND OTHER ABIOTIC STRESSES.

New Mexico State Univ., Las Cruces. Dept. of Chemistry  
For primary bibliographic entry see Field 3B.  
W91-01859

## 2J. Erosion and Sedimentation

#### DISSOLVED AND SUSPENDED SOLIDS TRANSPORT FROM COASTAL PLAIN WATERSHEDS.

Agricultural Research Service, Tifton, GA. Southeast Watershed Research Lab.  
For primary bibliographic entry see Field 5B.  
W91-01011

#### VARIATIONS IN SUSPENDED SEDIMENT AND ASSOCIATED TRACE ELEMENT CONCENTRATIONS IN SELECTED RIVERINE CROSS SECTIONS.

Geological Survey, Doraville, GA.  
A. J. Horowitz, F. A. Rinella, P. Lamothe, T. L. Miller, and T. K. Edwards.  
Environmental Science and Technology ESTHAG, Vol. 24, No. 9, p 1313-1320, September 1990. 7 tab, 10 ref.

Descriptors: \*Path of pollutants, \*River sediments, \*Sampling, \*Sediment transport, \*Suspended sediments, \*Trace elements, River mechanics, Spatial variation, Temporal distribution, Time series analysis.

Detailed sampling and subsequent analyses of riverine suspended sediment obtained from six rivers in the US (Cowlitz River, San Joaquin River, Arkansas River, West Fork Big Blue River, Des Plaines River, North Fork Kentucky River) indicate substantial differences in suspended sediment concentrations and possibly in some associated trace elements, depending on whether depth and width-integrated, point, or pumping samples are used. In addition, the data from time series, depth-integrated sampling indicate that there can be substantial short-term (on the order of 20-30 minutes) spatial and/or temporal variations in suspended sediment concentrations. Despite this, major element concentrations are remarkably stable both spatially and temporally. Trace element concentrations are generally stable; however, some spatial and temporal variations may occur. (Author's abstract)  
W91-01061

#### FLOODPLAIN DYNAMICS OF A WANDERING RIVER, DENDROCHRONOLOGY OF THE MORICE RIVER, BRITISH COLUMBIA, CANADA.

Northwest Community Coll., Terrace (British Columbia).  
For primary bibliographic entry see Field 2E.  
W91-01070

#### FLOW AND PARTICLE PATHS AT A NATURAL RIVER CONFLUENCE WITH COARSE BED MATERIAL.

Montreal Univ. (Quebec). Dept. of Geography.  
A. G. Roy, and N. Bergeron.  
Geomorphology GEMPEZ, Vol. 3, No. 2, p 99-112, June 1990. 8 fig, 23 ref.

Descriptors: \*Channel morphology, \*Geomorphology, \*River beds, \*River flow, \*River sediments, \*Sediment transport, Flow velocity, Gravel, River mechanics.

An investigation of flow and particle trajectories was conducted at a gravel bed confluence where the junction angle is gradually reduced from 60 to 20 degrees as the tributary joins the main channel. A shallow and elongated scour zone is present at the mouth of the tributary. Three flow stages ranging from 1/7 to 1/2 bankfull were recorded. Flow velocity vectors were measured from 5 bridges installed across the channels. Sediment transport paths were determined by following the progression of seeded marked particles through the confluence from May to October 1986. The results show that flow structure is responsive to stages. At lower stages (less than 1/3 bankfull) flow velocity vectors are controlled by local bed topography and specifically by the steeper slopes around the scour zone. At higher stages, velocity vectors become aligned with the plain geometry of the confluence. For all stages, surface flow velocities are higher in the scour zone. Bed shear stress computed from the law of the wall for the deepest flow is higher at the bottom of the scour zone compared to its side, head and exit. The trajectories of the particles seeded on the tributary pass through the scour zone. Particles coming from the main channel displayed a dual pattern first moving laterally towards the scour zone early in the season then following paths that are consistent with the plain geometry of the confluence. The shift in pattern reflects an increase in the peak discharges during the survey period. These results highlight the role of stage in controlling the flow dynamics and particle paths at the confluence. (Author's abstract)  
W91-01071

#### VARIABILITY OF WATER REPELLENCE IN THE DUNES ALONG THE DUTCH COAST.

Amsterdam Univ. (Netherlands). Lab. for Physical Geography and Soil Science.  
P. D. Jungerius, and J. H. de Jong.

Catena, Vol. 16, No. 3, p 491-497, June 1989. 2 fig, 3 tab, 15 ref.

Descriptors: \*Erosion, \*Soil water, \*The Netherlands, \*Water repellent soils, Organic matter, Soil profiles, Spatial distribution, Temporal distribution, Wind erosion.

The grey dunes along the Dutch coast are more sensitive to erosion by slope wash than erosion by wind, because the grey sand is extremely water repellent when dry. On the other hand, slope wash triggers wind erosion because the removal of the grey sand exposes the yellow sand which is sensitive to wind erosion. Water repellance of dune soils can best be measured with the waterdrop penetration time (WDPT); however, temporal and spatial variability of the WDPT values is high. There is a complex relationship between water repellance and organic matter content; age of organic matter appears to be more important than type of vegetation cover. Surface water repellance is generally much lower than the water repellance of the A horizon below the depth of a few millimeters, possibly due to the presence of algae. (Author's abstract)  
W91-01081

#### CHEMICAL AND PHYSICAL SPECIATION OF TRACE METALS IN FINE GRAINED OVERBANK FLOOD SEDIMENTS IN THE TYNE BASIN, NORTH-EAST ENGLAND.

Newcastle upon Tyne Univ. (England). Dept. of Geography.  
For primary bibliographic entry see Field 5B.  
W91-01082

## Field 2—WATER CYCLE

### Group 2J—Erosion and Sedimentation

**VARIABILITY OF PARTICLE SIZE CHARACTERISTICS OF SHEETWASH SEDIMENTS AND FLUVIAL SUSPENDED SEDIMENT IN A SMALL SEMIARID CATCHMENT, KENYA.**  
Toronto Univ. (Ontario). Dept. of Geography.  
R. A. Sutherland, and R. B. Bryan.  
Catena, Vol. 16, No. 4/5, p 189-204, August/October 1989. 5 fig, 5 tab, 51 ref.

Descriptors: \*Erosion, \*Particle size, \*Sediment transport, \*Sedimentation, \*Semi-arid climates, \*Suspended sediments, \*Watersheds, \*Catchments, \*Kenya, \*Mathematical models, \*Pollution load, \*Soil types, \*Storms.

The variability of particle size characteristics for sheetwash sediments and fluvial suspended sediments are investigated in three representative storm events in a small 0.30 sq km erodible semi-arid catchment. Suspended sediment output per event ranged from 340 to 810 t/sq km. Ninety-eight percent of the suspended sediment was less than 63 microm, and was supplied from remobilization of stored coluvium. Discharge and particle size class relationships were complex for various storm events, but were best described by third-order polynomial functions. Results of a one-way analysis of variance showed that concentrations of total suspended sediment, silt and sand varied significantly between storm events. Temporal variation of clay concentration in runoff waters were not significant, suggesting that a single hillslope source area contributed to the channel subsystem. The mean grain size and sorting of sheetwash sediments were significantly different from fluvial suspended sediment for individual storm events. Sheetwash sediments were coarser and more poorly sorted than fluvial suspended sediments. Enrichment ratios indicated selective erosion and transport of silt and clay, and preferential deposition of sands. If continuous measurements of suspended sediment concentrations are not available, rating curves must be established to predict catchment sediment loads and transport of contaminants from discharge data. Development of individual rating curves for the geochemically active fractions, silt and primarily clay-sized particles, would improve the estimates of nutrients and contaminant loads transported from drainage basins. (Brunone-PTD)  
W91-01084

**SPATIAL SCALE DEPENDENCE OF SEDIMENT DYNAMICS IN A SEMI-ARID BADLAND DRAINAGE BASIN.**  
Alberta Univ., Edmonton. Dept. of Geography.  
D. H. de Boer, and I. A. Campbell.  
Catena, Vol. 16, No. 4/5, p 277-290, August/October 1989. 6 fig, 2 tab, 29 ref.

Descriptors: \*Drainage area, \*Geomorphology, \*Runoff, \*Sediment transport, \*Sedimentation, \*Semi-arid climates, \*Watersheds, \*Hysteresis, \*Rainfall, \*Sandstones, \*Sediment concentration, \*Sediment discharge, \*Shales, \*Topography.

Problems of spatial scale transference are of key interest in drainage basin research. The objective of this study was to investigate the spatial scale dependence of sediment dynamics in semi-arid badland drainage basins. Simulated rainfall experiments indicated that on microscale plots runoff generation and sediment entrainment occurred when total rainfall exceeded 0.5 to 6 mm on pediment surfaces, 1.5 to 4 mm on sandstone surfaces, and 8 to 25 mm on shale surfaces. The sediment concentration/discharge relationship for two mesoscale basins displayed a change from clockwise to counterclockwise hysteresis when total rainfall for the initiation of flow in deep tunnel systems. The initiation of tunnel flow causes counterclockwise hysteresis due to a delayed increase in sediment concentrations during a runoff event. This state contrasts with the clockwise hysteresis caused by flushing in the early stages of runoff for smaller rainstorms. Comparison of microscale and mesoscale sediment dynamics indicates that microscale thresholds are not by necessity in evidence at the mesoscale. In addition, at the mesoscale, elements exist which are non-existent at the microscale, e.g. a deep tunnel system. The behavior of the mesoscale basin is dominated by these elements rather

than by the microscale components it contains. (Author's abstract)  
W91-01085

**LABORATORY EXPERIMENTS ON CRUST DEVELOPMENT AND RAINSPASH EROSION OF LOESS SOILS, CHINA.**  
Toronto Univ. (Ontario). Dept. of Geography.  
S. H. Luk, and Q. G. Cal.  
Catena, Vol. 17, No. 3, p 261-276, June 1990. 7 fig, 2 tab, 48 ref.

Descriptors: \*China, \*Crust development, \*Erosion, \*Loess, \*Rainfall impact, \*Soil compaction, \*Soil crusts, \*Soil morphology, \*Soil strength, \*Soil water.

Loess soil samples obtained from Wangjiagou, Lishi, China were subjected to laboratory simulated rainfall at intensities of 72 mm/hr for a range of durations from 1 to 30 minutes. Measured splash loss was found to relate to a soil strength index  $1/(P_{sub}20)^2$  squared. In this index,  $P_{sub}20$  is defined as penetration by a standard fall cone penetrometer at a moisture content of 20% and estimated from penetration-soil moisture regression equations. Similarly, subsequent splash loss of crust samples over a 10-minute period is significantly related to the antecedent soil strength index. As a result of crust development, strength of the surface soil is increased by as much as eleven times, while splash loss is reduced by a maximum of 76%. Data on splash loss and crust strength were used to infer that crust and seal development, while tending towards increasing stability as has been suggested previously, appear to follow a cyclic process of crust formation and disruption. This inference is supported by micromorphological observations. (Author's abstract)  
W91-01087

**HEAVY METAL DISTRIBUTION IN SEDIMENTS OF KRISHNA RIVER BASIN, INDIA.**  
McGill Univ., Montreal (Quebec). Dept. of Geological Science.  
For primary bibliographic entry see Field 5B.  
W91-01100

**LONGITUDINAL DISPERSION PROCESSES IN THE UPPER TAMAR ESTUARY.**  
Birmingham Univ. (England). Dept. of Civil Engineering.  
For primary bibliographic entry see Field 2L.  
W91-01127

**TEMPORAL VARIABILITY OF REMOTELY SENSED SUSPENDED SEDIMENT AND SEA SURFACE TEMPERATURE PATTERNS IN MOBILE BAY, ALABAMA.**  
New Orleans Univ., LA. Center for Research in Ocean and Space Sciences.  
For primary bibliographic entry see Field 2L.  
W91-01131

**DETERMINATION OF THE ORIGIN OF SUSPENDED MATTER AND SEDIMENTS IN THE ELBE ESTUARY USING NATURAL TRACERS.**  
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.  
For primary bibliographic entry see Field 2L.  
W91-01132

**SIMPLE PORE-WATER SAMPLER FOR COARSE, SANDY SEDIMENTS OF LOW POROSITY.**  
Nederlands Inst. voor Onderzoek der Zee, Texel.  
For primary bibliographic entry see Field 7B.  
W91-01147

**EQUILIBRIUM PARTITIONING AND BIOACCUMULATION OF SEDIMENT-ASSOCIATED CONTAMINANTS BY INFAUNAL ORGANISMS.**  
Environmental Protection Agency, Narragansett, RI. Environmental Research Lab.  
For primary bibliographic entry see Field 5B.

W91-01267

**PRODUCTION AND CARBON ISOTOPIC COMPOSITION OF BACTERIAL CO<sub>2</sub> IN DEEP COASTAL PLAIN SEDIMENTS OF SOUTH CAROLINA.**

Geological Survey, Columbia, SC. Water Resources Div.  
P. B. McMahon, D. F. Williams, and J. T. Morris.  
Ground Water GRWAP, Vol. 28, No. 5, p 693-702, September/October 1990. 7 fig, 3 tab, 32 ref.

Descriptors: \*Carbon dioxide, \*Carbon isotopes, \*Coastal plains, \*Diagenesis, \*Geochemistry, \*Marine sediments, \*Water chemistry, \*Bacteria, \*Organic matter, \*South Carolina.

Geochemical data accumulated since the 1940s have provided indirect evidence that bacterial CO<sub>2</sub> can significantly impact the chemical evolution of groundwater. Recent data strongly suggest that bacterial CO<sub>2</sub> is an important reactant in groundwater. Rates of bacterial CO<sub>2</sub> production in laboratory incubations ranged from 0 to 2,750 nanomoles of CO<sub>2</sub> per gram of South Carolina Coastal Plain sediment per day. On average, CO<sub>2</sub> production was greater in downpied sediments than in uppied sediments. There was no relation between CO<sub>2</sub> production and total organic carbon content of the sediment. The carbon isotopic composition of bacterial CO<sub>2</sub> ranged from -29.7 to -18.0 per mil and is controlled in part by the isotopic composition of the sedimentary organic matter from which the CO<sub>2</sub> is derived. The isotopic composition of CO<sub>2</sub> from downpied sediments was enriched in <sup>13</sup>-carbon by 5% on average, relative to CO<sub>2</sub> from uppied sediments. Measurements of the production and carbon isotopic composition of bacterial CO<sub>2</sub> given here provide evidence linking bacterial CO<sub>2</sub> to dissolved inorganic carbon in Coastal Plain aquifers of South Carolina. (Author's abstract)  
W91-01297

**POLYCHLORINATED BIPHENYLS IN HOUSATONIC RIVER SEDIMENTS IN MASSACHUSETTS AND CONNECTICUT, USA: DETERMINATION, DISTRIBUTION, AND TRANSPORT.**  
Connecticut Agricultural Experiment Station, New Haven.  
For primary bibliographic entry see Field 5B.  
W91-01328

**SUSPENSION AND SETTLEMENT OF PARTICLES IN FLOWING WATER: COMPARISON OF THE EFFECTS OF VARYING WATER DEPTH AND VELOCITY IN CIRCULATING CHANNELS.**  
Freshwater Biological Association, Ambleside (England). Windermere Lab.  
C. S. Reynolds, M. L. White, R. T. Clarke, and A. F. Marker.  
Freshwater Biology FWBLAB, Vol. 24, No. 1, p 23-34, August 1990. 4 fig, 2 tab, 16 ref.

Descriptors: \*Flow channels, \*Flow velocity, \*Sediment transport, \*Sedimentation rates, \*Suspended solids, \*Water depth, \*Club mosses, \*Ecological distribution, \*Plankton, \*Sinking rate, \*Spores, \*Suspension.

An experimental study was designed to test the hypothesis that the loss of particles from suspension in flowing water follows an exponential decay function (the exponent is influenced more by water depth than water velocity). Successive experiments used suspensions of *Lycopodium* spores which were introduced into one of the circulating channels maintained at its Waterston site, Dorset, under different combinations of water depth and pumping rate. In each experiment the concentration of introduced spores declined exponentially through time. The bulked, transformed data-set also conformed well to a single regression against a common time scale which explained over 94% of the accumulated variances. The variance unexplained by the regression was apportioned among the components distinguishing between experiments: experimental differences in starting concen-

## Erosion and Sedimentation—Group 2J

tration, water depth and pumping rate (velocity). This analysis revealed that, after elimination of different initial concentrations, only water depth produced a significant effect, through its relation to the settling velocity of the Lycopodium. Therefore, water depth and not flow velocity proved to be the main controlling variable determining the rate of sinking loss in these experiments. Nevertheless, flow velocity is an important component in the sense that it influences the horizontal distance traveled by the residual spore suspension through the time period required for complete settlement. In applying the findings to the maintenance of planktonic diatoms in rivers, it was found that both the survival of a potential growth inoculum and its downstream dispersion are strongly time-dependent and are enhanced by greater channel depths. (Author's abstract)  
W91-01340

#### SILTATION OF STONE-SURFACE PERIPHYTON IN RIVERS BY CLAY-SIZED PARTICLES FROM LOW CONCENTRATIONS IN SUSPENSION.

Otago Univ., Dunedin (New Zealand). Dept. of Zoology.  
A. A. Graham.  
Hydrobiologia HYDRB8, Vol. 199, No. 2, p 107-115, July 24, 1990. 2 tab, 43 ref.

Descriptors: \*Clays, \*New Zealand, \*Periphyton, \*Rivers, \*Siltation, \*Suspended sediments, Food chains, Macroinvertebrates, Particle size, Sediment deposition, Streambeds, Turbidity.

The observation that deposits of fine sediment are found on stream beds only in areas of slower water velocity promotes a common misunderstanding of the depositional behavior of fine suspensions in flowing water and a disregard for the potential for siltation effects on the biota on the surface of stones in fast flowing water. A model for deposition from turbulent water, whereby particles are lost from suspension where water currents are slowed by boundary friction, provides an explanation for silt infiltration into epilithic periphyton. Theoretically calculated deposition rates of clay sized mineral particles at low suspended concentrations (2 to 5 g/cu m) were found to account for observed rates of silt accumulation in epilithic periphyton in a braided river in the South Island of New Zealand. At concentrations between 1 and 10 g/cu m of suspended mineral silt during normal flow, silt accumulation in epilithic periphyton accounted for about 50% of its dry weight. This caused a reduction in the mean organic content of the periphyton to 22% of the dry weight compared to 52% in a reference stream where the concentration of suspended mineral particles was less than 1.0 g/cu m during non-freshet flow. Siltation of periphyton reduces its value/availability as food for the aquatic macroinvertebrates that unselectively consume periphyton. Food value can be a major influence on several aspects of invertebrate production: density, growth rate, survival, size at pupation, emergence success, and fecundity. The effect of fine silt deposition on the organic-inorganic proportions of the periphyton will vary, depending on the growth rate of the periphyton standing crop relative to the rate of accumulation of inorganic silt. (White-Reimer-PTT)  
W91-01353

#### ESTIMATE OF SNOW AVALANCHE DEBRIS TRANSPORT, KAGHAN VALLEY, HIMALAYA, PAKISTAN.

Waterloo Univ. (Ontario). Dept. of Geography.  
I. Bell, J. Gardner, and F. de Scally.  
Arctic and Alpine Research ATLPAV, Vol. 22, No. 3, p 317-321, August 1990. 2 fig, 2 tab, 12 ref.

Descriptors: \*Avalanches, \*Pakistan, \*Sediment transport, \*Snow, \*Kaghan Valley, Sediment load.

Debris transport by snow avalanches in the front ranges of the Himalaya in northern Pakistan is described using estimates of sediment concentration in avalanche snow deposits. Data were collected from two end-of-season avalanche deposits in the Kaghan Valley. Sediment concentration estimates and measurements of avalanche deposit vol-

umes were used to produce estimates of total sediment load. From these, deposit area accretion values of 0.74 and 0.21 mm for the two deposits representing the 1986/87 avalanche season were derived. The estimates reported here are within the range of avalanche debris transport and deposition values reported in previous research. (Author's abstract)  
W91-01371

#### BIOSEDIMENTOLOGY AND PALEOHYDROLOGY OF HOLOCENE STROMATOLITES FROM LAKE TANGANYIKA (BIOSEDIMENTOLOGIE DES STROMATOLITES HOLOCENES DU LAC TANGANYIKA (BURUNDI). IMPLICATIONS HYDROLOGIQUES).

Quebec Univ., Montreal. Centre Geochimie Isotopique et Geochronologie.  
J. Casanova, and C. Thouin.  
Bulletin de la Societe Geologique de France, Vol. 8, No. 4, p 647-656, July 1990. 3 fig, 1 tab, 2 plates.

Descriptors: \*Algae, \*Climatology, \*Lake Tanganyika, \*Limnology, \*Paleohydrology, \*Sedimentology, \*Stromatolites, Biological studies, Copper, History, Lake Kivu, Light intensity, Salinity.

Lake Tanganyika stromatolites occur at depths ranging from 6 to 60 m. They mark former low lake levels and document the recent hydroclimatic history of the basin from 3,500 to 1,300 B.P. During this period, conditions more arid than today closed the Tanganyika basin, and the water level dropped to 10 m below the present depth. Stromatolites developed continuous planar encrustations on vertical surfaces, as well as thick encrustations around blocks and pebbles. Biological competition in benthic microbial communities favored columnar growth; the resulting structures show digitate, dendroid and anastomosed branching styles. Stromatolites occurrence depends on limnological parameters such as salinity, light, Ca concentration, and turbidity, and their growth is partly controlled by sporadic discharges of eutrophic waters from Lake Kivu. Lake Tanganyika stromatolites illustrate the complexity of freshwater stromatolites ecological requirements that explains their relative scarcity in East African rift. (Author's abstract)  
W91-01372

#### ANCIENT CHANNELS OF THE SUSQUEHANNA RIVER BENEATH CHESAPEAKE BAY AND THE DELMARVA PENINSULA.

Geological Survey, Woods Hole, MA.  
S. M. Colman, J. P. Halka, C. H. Hobbs, R. B. Mixon, and D. S. Foster.  
Geological Society of America Bulletin, Vol. 102, No. 9, p 1268-1279, September 1990. 11 fig, 45 ref.

Descriptors: \*Chesapeake Bay, \*Delmarva Peninsula, \*Glaciation, \*Paleohydrology, \*River channels, \*Sea level, \*Sedimentology, \*Stratigraphy, \*Susquehanna River, Channels, Glaciohydrology.

Three generations of the ancestral Susquehanna River system have been mapped beneath Chesapeake Bay and the southern Delmarva Peninsula. Closely spaced seismic reflection profiles in the bay, and boreholes in the bay and on the southern Delmarva Peninsula allow detailed reconstruction of each paleochannel system. The channel systems were formed during glacial low sea-level stands, and each contains a channel-fill sequence that records the subsequent transgression. The trunk channels of each system are 2 to 4 km wide and are incised 30 to 50 m into underlying strata; they have irregular longitudinal profiles and very low gradients within the Chesapeake Bay area. The three mainstem channels diverge from the head of the bay toward the southeast. The channels are rarely coincident, although they commonly intersect. All three main channels pass beneath the southern Delmarva Peninsula forming an age progression from north (oldest) to south (youngest) beneath the peninsula, and from east (oldest) to west (youngest) beneath Chesapeake Bay. Southward progradation of the tip of the peninsula during interglacial high sea-level stands caused southward migra-

tion of the mouth of the bay, so that the next generation of channels were incised progressively further toward the southwest. The youngest paleochannel is clearly of late Wisconsinian age, about 18 ka, and the intermediate one appears to be late Illinoian in age, or about 150 ka. The age of the oldest paleochannel is not well constrained, but it is in the range of about 200 to 400 ka. The three paleochannel systems imply a dynamic coastal-plain environment and at least two previous generations of the Chesapeake Bay. Both the Chesapeake Bay and the Delmarva Peninsula have changed considerably in the past half million years. (Author's abstract)  
W91-01378

#### PITFALLS OF SEQUENTIAL EXTRACTIONS.

Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.

For primary bibliographic entry see Field 2K.

W91-01428

#### PECULIARITIES OF THE FORMATION OF BOTTOM DEPOSITS IN A CLOSED-COOLING POND.

For primary bibliographic entry see Field 8C.  
W91-01444

#### MONITORING THE EROSION OF AN EXPRESSWAY DURING ITS CONSTRUCTION: PROBLEMS AND LESSONS.

Macquarie Univ., North Ryde (Australia). School of Earth Sciences.

S. J. Riley.

Hydrological Sciences Journal HSJODN, Vol. 35, No. 4, p 365-381, August 1990. 7 fig, 29 ref. NSW Department of Main Roads, funds administered by the Soil Conservation Service of NSW.

Descriptors: \*Road construction, \*Sediment erosion, \*Soil erosion, Accelerated erosion, Australia, Catchment areas, Data acquisition, Drainage patterns, Electronic equipment, Electronic recorders, Monitoring, Sediment discharge, Sediment load, Sediment sampler.

Road construction sites are major sources of sediment and without careful control large quantities of sediment can be moved off-site during erosional events and cause significant economic and environmental damage. The dynamic nature of the catchment materials and drainage network require intensive and repetitive monitoring. The quick response times of the floods present problems of monitoring and gaging. The large quantities of sediment eroded from the F3 Expressway extension in the northern suburbs of Sydney, NSW, Australia, and the lack of defined channels within the catchment presented several problems of discharge and sediment load sampling. The monitoring equipment at the catchment outlet, namely pump samplers and capacitance-based water level sensors, was computer controlled, but for partial area monitoring manual methods were used together with Gerlach traps and erosion pins. The monitoring at the catchment outlet was cost-effective because of the use of electronic equipment. The experience on the F3 Expressway in NSW showed that the frequency of sensor sampling had to be on the order of 30 seconds. The high sediment loads, with coarse sediment concentrations in excess of 100 g/L, demanded frequent maintenance of equipment, particularly the pump samplers, and the need to install backup samplers to reduce the loss of data. In the future, use should be made of radio transmission of data from sensors to data logger to minimize the problems of disturbance. Low level photogrammetric surveys need to be undertaken after each storm event in order to record the detail of erosion and source areas. (Fish-PTT)  
W91-01459

#### RAIN SCAVENGING OF TEPHRA AEROSOLS FROM MOUNT ST. HELENS 1980 ERUPTIONS.

Arkansas Univ., Fayetteville. Dept. of Geology.  
For primary bibliographic entry see Field 2B.  
W91-01468

## Field 2—WATER CYCLE

### Group 2J—Erosion and Sedimentation

#### DEVELOPMENT, CALIBRATION AND FIELD TESTING OF A SOIL LOSS AND A RUNOFF MODEL DERIVED FROM A SMALL-SCALE PHYSICAL SIMULATION OF THE EROSION ENVIRONMENT ON ARABLE LAND IN ZIMBABWE

Institute of Agricultural Engineering, Harare (Zimbabwe).  
H. A. Elwell.

Journal of Soil Science JSSCAH, Vol. 41, No. 2, p 239-253, June 1990. 11 tab, 18 ref.

Descriptors: \*Agriculture, \*Data interpretation, \*Land loss, \*Rainfall-runoff relationships, \*Runoff forecasting, \*Soil erosion, \*Zimbabwe, Arable soils, Calibrations, Cropland, Field tests, Mathematical models, Model studies, Model testing, Rill erosion, Sheet erosion.

Measured soil losses from field plots under natural rainfall are the traditional data source for building farm-oriented prediction models. An exploratory investigation was made into the potential of small-scale physical mimicry in the development of mathematical models which, after calibration, would yield predictions of field-scale runoff and soil losses arising from sheet erosion (interill) processes. Soil loss and runoff prediction models were developed for a clay soil in Zimbabwe from a five-factor small-scale physical simulation of the field environment by following a central composite rotatable experimental design. The uncalibrated models efficiently ranked observed annual soil losses and runoff over a 4-year period between nine field treatments. Each treatment consisted of two bare fallows, two weed fallows and five plots cropped to soybeans. When calibrated against the field data, the soil loss model predicted the 4-year mean losses from cropped and bare fallow treatments to within 6% for two of the plots, to within 12% for five of the plots, and to within 14% for all seven treatments. Over the same period, the runoff model predicted mean annual runoff for the cropped and bare fallow treatments to within 4% for four of the plots and to within 16% for all seven treatments. Percentage of vegetative cover proved to be an adequate parameter for describing the role of the soybean crop in runoff and soil loss processes for a wide range of planting densities of the crop. However, it did not prove to be an efficient index for weed fallows and it was apparent that factors other than simple above-ground cover became important soon after germination. (Author's abstract)  
W91-01478

#### DEVELOPMENT OF BED FEATURES.

Auckland Univ. (New Zealand). Dept. of Civil Engineering.

A. J. Raudkivi, and H. H. Witte.  
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 9, p 1063-1079, September 1990. 10 fig, 3 tab, 12 ref, append.

Descriptors: \*Alluvial channels, \*Channel morphology, \*Geomorphology, \*Mathematical models, \*Model studies, \*River beds, \*Sediment transport, \*Streambeds, Flow models, Numerical analysis, Uniform flow.

The concept of unification, the opposite of branching theories used in biological sciences, has been introduced as a new avenue to investigate the behavior of bed features in alluvial channels under unidirectional flow. The approach starts with the theoretical concepts according to which the features propagate at speeds inversely proportional to their heights. This leads to coalescence and rearrangement of the general pattern of bed features. Numerical experiments show that an initial large number of arbitrary bed disturbances rapidly reduces to a small number. If one feature reaches the maximum height for given flow conditions, smaller features pass through it. An initial uniform distribution of heights of disturbances slowly changes into a broad distribution of heights with some at the maximum height, similar to what is observed in nature. (Author's abstract)  
W91-01491

#### MODELING EROSION OF SAND AND SILT BED RIVER.

Barnett Consultants, Hamilton (New Zealand).

H. L. MacMurray, and M. N. R. Jaeggi.  
Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 9, p 1080-1089, September 1990. 6 fig, 11 ref.

Descriptors: \*Hydraulic models, \*Model studies, \*River sediments, \*Sediment erosion, \*Sediment transport, \*Stream erosion, Alluvial plains, Channel erosion, Lake sediments, Sand, Silt, Wash load.

A conventional numerical river model that failed to adequately reproduce the erosion of a 20-km stretch of a sand-bed river, was modified to allow a substantial proportion of the eroded material to be designated as transported in the form of wash load. This reflects the formation of the river plain from proglacial lake sediments, which commonly have a large silt fraction. Because wash load has practically no effect on the transport capacity, except at very high concentrations, less of the transport capacity is devoted to transport of already eroded material, and more to further erosion. By assuming the proportion of silt to be 40%, the observed erosion could be satisfactorily reproduced. The average wash-load concentration that follows from this assumption is quite small. (Author's abstract)  
W91-01492

#### THREE-DIMENSIONAL COMPUTATION OF FLOW AND BED DEFORMATION.

Civil Engineering Research Inst., Sapporo (Japan).  
Y. Shimizu, H. Yamaguchi, and T. Itakura.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 9, p 1090-1108, September 1990. 11 fig, 28 ref, append.

Descriptors: \*Channel morphology, \*Data interpretation, \*Flow models, \*Model studies, \*Numerical analysis, \*River beds, \*Three-dimensional model, Bed load, Channel flow, Dimensional analysis, Flow equations, Flow velocity, Sediment transport, Suspended load.

Several studies have been made to evaluate flow and bed variation in curved channels. Numerical models are useful in that they can be applied to channels with various plane geometries and boundary conditions. A three-dimensional (3D) flow model was developed to improve the defects of a two-dimensional (2D) model. Calculated results were compared with experiments as well as with results calculated by the 2D model. It was found that the flow field is predicted more closely by the 3D model than the 2D model. A simplification of the full 3D model assumes the depthwise profile of the velocity to be logarithmic. This approach was favorably tested in the calculation of flow in a meandering bend. The simplified 3D model was applied to the computation of bed deformation by bed load as well as suspended load transport in meandering channels. Good agreements were found in comparison with the experimental results. A definite difference between the 3D and 2D models was found in the predicted bed deformation with suspended load. Evaluations of the flow and bed deformation by the proposed model were clearly demonstrated through application examples, and the validity of the new calculation model was verified. (Author's abstract)  
W91-01493

#### CHANGES IN STREAM MORPHOLOGY AND STORM TRANSPORT OF SESTON FOLLOWING WATERSHED DISTURBANCE.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.

S. W. Golladay, J. R. Webster, and E. F. Benfield.  
Journal of the North American Benthological Society JNASEC, Vol. 6, No. 1, p 1-11, March 1987. 4 fig, 6 tab, 49 ref. National Science Foundation Grants BSR 8316000 and BSR 8012093.

Descriptors: \*Appalachian Mountains, \*Channel morphology, \*Forest watersheds, \*Sediment transport, \*Seston, \*Storm runoff, \*Streams, Flow discharge, Headwaters, North Carolina, Organic matter, Particulate matter, Seasonal variation, Storms.

Headwater streams are closely linked to the areas they drain, thus watershed disturbance can cause

severe disruption within streams. Surveys of stream morphology and measurements of particulate organic matter (seston) transport were made in four streams to examine response to forest disturbance. Seston was sampled during baseflows and stormflows in streams draining an 8-year-old clearcut, a 25-year-old clearcut, and two reference watersheds in the southern Appalachian Mountains of North Carolina. The surveys indicated that there were fewer debris dams and organic matter accumulations in disturbed streams. Baseflow seston concentrations varied seasonally (0.5 to 1.0 mg/L in winter and 3.0 to 7.0 mg/L during summer). Baseflow seston concentrations did not differ consistently between streams. In all streams, seston concentration increased with increasing discharge during storms and was positively correlated with the rate of change of discharge during rising flows. Seston concentrations decreased during peak flows and gradually declined as discharge returned to baseflow. Average seston concentrations during storms were generally highest in streams draining disturbed watersheds, and export was significantly higher in streams draining disturbed watersheds. Storm transport varied with season, storm intensity, and storm duration. Baseflow seston concentrations in streams draining disturbed areas may return to normal levels within a few years following disturbance; however, concentrations during storms may remain elevated for many years. (Author's abstract)  
W91-01505

#### NUMERICAL SIMULATION OF GRAVEL RIVER WIDENING.

Delaware Univ., Newark. Dept. of Geology.

J. E. Pizzuto.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 1971-1980, September 1990. 14 fig, 1 tab, 35 ref.

Descriptors: \*Alluvial channels, \*Bank erosion, \*Channel morphology, \*Erosion, \*Gravel, \*Model studies, \*River widening, \*Stream banks, Bank failure, Flumes, Sediment transport.

A numerical model, which simulates bank erosion in a straight channel composed of noncohesive sediment, predicts the distribution of boundary shear stress, cross-channel sediment transport rates and the evolution of the bed topography. When erosion produces a bank slope which exceeds the angle of repose, widening occurs by a planar bank failure. Equilibrium channels produced by the model have flat beds and curved bank regions which are similar to the classical cosine stable bank profile. Equilibrium values of dimensionless depth are inversely proportional to the slope, as suggested by previous studies. The model also reproduces the exponential cross sections created during laboratory experiments. However, as the computations proceed, the exponential profiles slowly develop a flat bed and a curved bank region, suggesting that past flume experiments of channel widening may have frequently been terminated before a stable equilibrium form had evolved. (Author's abstract)  
W91-01516

#### THEORETICAL MODEL OF OPTIMAL DRAINAGE NETWORKS.

Virginia Univ., Charlottesville. Dept. of Environmental Sciences.

For primary bibliographic entry see Field 2E.  
W91-01526

#### STATISTICAL CHARACTERISTICS OF SOME ESTIMATORS OF SEDIMENT AND NUTRIENT LOADINGS.

Instituto de Pesquisas Hidraulicas, Porto Alegre (Brazil).

R. T. Clarke.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 2229-2233, September 1990. 4 fig, 1 tab, 8 ref.

Descriptors: \*Model studies, \*Nonpoint pollution sources, \*Probability distribution, \*Sediment load, \*Sediment yield, \*Statistical analysis, Estimating, Mathematical models, Sediment discharge.

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Some of the statistical characteristics of estimators of sediment load which require the integration over time of the product of a concentration (c) with a discharge (q) were examined. Using a bivariate lognormal distribution for the discrete variables approximate confidence intervals were calculated for an unbiased estimator of sediment yield, and the exact sampling distribution of the estimator was obtained by numerical integration of a Fourier transform. This permits an investigation of the rapidity with which the estimator tends to normality. Provided the data sequences are serially independent, the same technique can be used to obtain the distribution of an estimator without the assumption of bivariate lognormality. Some characteristics of an 'extrapolation' estimate of sediment yield were derived, in which power law regression is used to estimate concentration from discharge when measurements of the latter are more plentiful than the former. Subject to model assumptions, the extrapolation estimate was found to underestimate the true sediment load, although its variance is smaller; this confirms previously published results obtained by empirical sampling and alternative theoretical approaches. (Author's abstract)

W91-01538

#### DEPRESSIONAL STORAGE FOR MARKOV-GAUSSIAN SURFACES.

National Soil Erosion Lab., West Lafayette, IN. C.H. Huang, and J. M. Bradford. Water Resources Research WREARQ, Vol. 26, No. 9, p 2235-2242, September 1990. 12 fig, 2 tab, 13 ref.

Descriptors: \*Depression storage, \*Erosion, \*Markov process, \*Mathematical analysis, \*Ponding, \*Rainfall-runoff relationships, \*Soil erosion, \*Roughness, \*Soil physical properties, \*Storage, \*Topography.

Processes during rain events, such as infiltration, runoff, soil erosion, and crust formation, are influenced in part by depression storage and surface roughness. If the surface topography is known, its potential depression storage can be calculated. A study was conducted to relate the statistical parameters for quantifying surface roughness to depression storage. Analysis of topographic data sets digitized at millimeter grids by a laser scanner showed that soil roughness can be quantified by a Markov-Gaussian (M-G) type random process. A Monte Carlo simulation procedure was used to find the mean ponding characteristics from simulated M-G surfaces. Depression storages were found to be functions of two M-G parameters, two sample length scales, and the slope steepness. The Markov parameters are the global variance and the correlation length scale (L), and the sample length scales are grid spacing (delta x) and side length (L sub s). After proper scaling, all storage functions collapsed into two non-dimensional relationships: (1) storage at zero slope as a function of relative sample length scale, and (2) storage as a function of scaled slope. When L = 0, simulated surfaces followed the random Gaussian model and the non-dimensional storage was only a function of scaled slope. Storages calculated from digitized elevation data sets with M-G type statistics agreed well with results obtained from simulated surfaces. (Author's abstract)

W91-01539

#### STUDY ON GEOCHEMISTRY AND GEOCHEMICAL CLASSIFICATION OF ELEMENTS B, F, RB AND SR IN YELLOW SEA (HUANG HAI) SEDIMENTS.

Academia Sinica, Qingdao (China). Inst. of Oceanology. J. T. Wang. Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 6, p 517-527, November 1989. 6 fig, 5 tab, 13 ref.

Descriptors: \*Boron, \*Calcium, \*Fluorine, \*Geochemistry, \*Marine sediments, \*Rubidium, \*Strontium, \*Yellow Sea, Clay minerals, Cluster analysis, Marine pollution, Metals, Particle size, Sediment distribution, Spatial distribution, Statistical analysis.

The abundance of the boron, fluorine, rubidium, and strontium through distribution characteristics, correlative relationships, and other geochemical characteristics were studied. Elemental compositions were correlated to the grain size of the sediment. It was found that concentrations of B, F, and Rb increased with decreasing sediment grain size, while Sr levels decreased. Further, B, F, and Rb were found in greater association with clay minerals. Levels of B and F in heavy minerals were much higher than in lighter minerals. Geochemically, B and Rb were found to have a close relationship with Al, and F with siderophile elements. Concentrations of Sr relate directly to Ca levels, and become further enriched in carbonates. R-cluster analysis showed that the 19 elements analyzed in the Yellow Sea sediments can be divided into two groups: one primarily from terrigenous materials, and the other from authigenic and biogenic accumulation. Q-cluster analysis suggested that these same Yellow Sea sediments be divided into three types: (1) composed of fine and current sediments containing more B, F, Rb and other phlo-clay elements. This type of sediment is formed in weakly hydrodynamic and reducing environments; (2) large grain and residual sediments, which enrich Sr and Ca, and form in strongly hydrodynamic and residual sedimentary environments; and (3) large grain and current sediments which have characteristically low levels of Sr, Ca, B, F, Rb, and other elements. This type of sediment is formed mainly in strong hydrodynamic and temporal sedimentary environments. The major controlling factors for the geochemical characteristics of elements found in Yellow Sea sediments are: elemental properties, material sources, sediment types, hydrodynamic conditions, and physicochemical conditions. (Author's abstract)

W91-01566

#### LATERAL DISTRIBUTION OF SUSPENDED SEDIMENTS IN NEARSHORE WATER OF MUDDY COAST OF LIANYUNGANG HARBOR (IN CHINESE).

East China Normal Univ., Shanghai. Inst. of Estuarine and Coastal Research. D. S. Chen, L. Jin, Y. D. Tang, and A. Y. Yu. Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 20, No. 6, p 544-553, November 1989. 10 fig, 2 tab, 3 ref. English summary.

Descriptors: \*China, \*Sediment distribution, \*Sediment transport, \*Statistical models, Lianyungang, Mathematical models, Model studies, Spatial distribution, Tidal currents, Wave action, Wave energy, Wave height, Yangshan Island.

The lateral distribution of sediments in waters of the Lianyungang Harbor were modeled using the statistical distribution of wave heights from the wave energy method. The mathematical expression for the region beyond the breaking wave zone was derived by superimposing data describing several lines of sediment dispersal. Sediment concentrations beyond the breaking zone were calculated from the wave energy and the position of the breaking wave zone. This model can calculate the distribution of sediment levels both inside and outside the breaking wave zone. The values calculated from the model match sediment concentrations actually measured offshore. The mixing and suspension of sediments inside the breaking zone and the dispersion of sediments by tidal currents offshore are described. The concentration of sediments inside the breaking zone increased with wave height at Yangshan island. Data correlating wave energy with wave height are also given. (King-PTT)

W91-01567

#### MICROORGANISMS IN MARINE SEDIMENTS: CONSIDERATIONS CONCERNING ACTIVITY MEASUREMENTS.

Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde. L.-A. Meyer-Reil. Ergebnisse der Limnologie ERLIA6, Vol. 34, p 1-6, 1990. 3 fig, 9 ref.

Descriptors: \*Analytical methods, \*Marine bacteria, \*Marine ecology, \*Marine sediments, \*Microbiological studies, \*Microorganisms, Bacterial analysis, Benthic environment, Enzymes, Sediment analysis, Sediments.

The measurement of microbial metabolic activity in marine sediments suffers from an insufficient knowledge of benthic microbial life and from an uncritical application of analytical methods to the sediment environment. Disturbance of the sediments causes a considerable stimulation of microbial metabolism. In sediments with high adsorption capacities and/or low microbial activity, extrapolated metabolic rates may vary considerably, depending on the choice of controls to account for the non-biological activity. Although of fundamental importance for the evaluation of the oxidation of organic substrates in sediments, the measurement of extracellular enzymatic activity still suffers from a number of drawbacks. Hydrolysis rates depend on the nature and the concentration of model substrates used to measure activity. New approaches based upon a critical application of methods, and taking into account the basic characteristics of benthic microbial life, are needed to study microbial metabolism in sediments. (MacKee-PTT)

W91-01585

#### MEASUREMENT OF CO<sub>2</sub>-FIXATION IN SEDIMENTS: SOME THEORETICAL AND TECHNICAL ASPECTS.

Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde. W. Reichardt.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 7-16, 1990. 9 fig, 2 tab, 15 ref.

Descriptors: \*Analytical techniques, \*Benthic environment, \*Carbon dioxide, \*Diagenesis, \*Sediment analysis, \*Sediment chemistry, \*Sediments, Carbon dioxide fixation, Energy transfer, Marine sediments, Microbiological studies, Microorganisms.

To assess the contribution of dark fixation of carbon dioxide to benthic energy flow, rate measurements have to be specified in terms of 'autotrophic primary biosynthesis'. Determination of rates of aerobic chemosynthetic carbon dioxide fixation in marine sediments was attempted with iodoacetamide as an inhibitor of ribulose 1,5-bisphosphate carboxylase dependent pathways. Techniques established for phytoplankton primary productivity studies became very complicated when applied to sediments. In acidified sediment samples, the larger fraction of assimilated carbon was found in the dissolved, acid-soluble pool. To avoid artificial stimulation of carbon dioxide incorporation, core injection of small volumes of the substrate solution is recommended; however, control of its distribution during minimal incubation periods is desirable. (Author's abstract)

W91-01586

#### MEASUREMENT OF EXOENZYMATIC ACTIVITY IN STREAMBED SEDIMENTS USING METHYLUMBELLIFERYL-SUBSTRATES.

Max-Planck-Inst. fuer Limnologie, Schlitz (Germany, F.R.). Limnologische Flussstation. J. Marxsen, and K.-P. Witzel. Ergebnisse der Limnologie ERLIA6, Vol. 34, p 21-28, 1990. 4 fig, 1 tab, 17 ref.

Descriptors: \*Analytical techniques, \*Biodegradation, \*Enzymes, \*Microbial degradation, \*Sediment chemistry, \*Sediments, \*St. eams, \*Substrates, Beta-D-glucosidase, Enzyme activity, Europe, Extracellular metabolism, Sediment analysis, Streambed sediments.

The microbial degradation of macromolecular organic compounds in aquatic environments involves a combination of processes, including extracellular enzymatic hydrolysis, the uptake of monomeric and oligomeric molecules into cells, and respiration. Methodological investigations of extracellular enzymatic hydrolysis were undertaken in subsurface stream habitats. 4-Methylumbelliferyl substrates

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were used to measure the activity of extracellular beta-D-glucosidase and phosphatase in small central European streams. The substrates could be used for stream water, sandy sediments, and coarser artificial substrata. Although beta-D-glucosidase activity per unit surface area was about ten times higher in coarse particulate sediments than in sandy sediments, maximum activity per unit volume was observed in sandy sediments. This means that for the streams as a whole, the greater proportion of the exoenzymatic cleavage activity occurs in the sandy streambed deposits. (MacKee-PTT)  
W91-01587

**METHOD OF MEASURING THE DEHYDROGENASE ACTIVITY OF SEDIMENTS.**  
Sofia Univ. (Bulgaria). Dept. of Ecology.  
B. B. Boyanovsky.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 29-31, 1990. 1 fig, 1 ref.

Descriptors: \*Dehydrogenase activity, \*Enzymes, \*Microbiological studies, \*Microorganisms, \*Sediment chemistry, \*Sediments, \*Water chemistry, Anoxic conditions, Bacterial physiology, Benthic environment, Bottom sediments, Eutrophic lakes, Lake sediments, Sediment analysis.

A new modification of the dehydrogenase activity (DHA) test, using 2,3,5-triphenyl tetrazolium chloride (TTC) for the estimation of benthic microbial community metabolism in oxic and anoxic sediment is described. Suggestions for use include: a preliminary quantification of interstitial water in sediment samples in order to obtain a definite concentration of TTC and other chemicals; a one-hour incubation time; strict maintenance of anoxic conditions (even in primary oxic sediment samples); use of blanks, treated like other samples, but poisoned with formaldehyde; and measurement of TT-formazan extract absorbance at 520 nm instead of 485 nm. In a moderately eutrophic lake at the depth of 3 m, a 63% higher DHA was measured in the surface oxic sediment layer than in the anoxic layer 20 cm deep. Such activities are higher than in some activated sludges and approximately 10 times higher than in 1 cu m of the most-active river periphyton studied. Further examination of the effect of redox potentials is necessary and the results should eventually be related to the biomass and compared to other activity tests, especially in oxygen uptake. (MacKee-PTT)  
W91-01588

**BACTERIAL PRODUCTIVITY IN SEDIMENTS.**  
Commonwealth Scientific and Industrial Research Organization, Cleveland (Australia). Marine Labs.  
For primary bibliographic entry see Field 2H.  
W91-01608

**CAUSES AND CHARACTER OF MOVEMENTS OF THE LOAMY SAND MORAINES IN THE FOUNDATION OF THE PLYAVINYAS HYDROELECTRIC STATION POWERHOUSE.**  
For primary bibliographic entry see Field 8D.  
W91-01651

**NONLINEAR SOLUTION OF AGGRADATION AND DEGRADATION IN CHANNELS.**  
Detroit Water and Sewerage Dept., MI.  
M. A. Gill.  
Journal of Hydraulic Research JHYRAF, Vol. 25, No. 5, p 537-547, 1987. 4 fig, 8 ref.

Descriptors: \*Aggradation, \*Alluvial channels, \*Degradation, \*Mathematical analysis, \*Sedimentation, \*Mathematical studies, River mechanics, Sediment supply, Sediment transport, Streamflow.

Channel aggradation and degradation are important in river control engineering. Aggradation occurs in an alluvial river when the imposed sediment supply exceeds the sediment transport capacity of the flow. The flow tends to degrade the river channel when its sediment transport capacity exceeds the sediment supply rate. A perturbation solution was presented for the non-linear aggradation/degradation problem.

The first order solution was the linear solution published previously. The second order solution was believed to account for the non-linear character of the aggradation/degradation equation. A non-linear correction was needed when the ratio of the initial and final sediment supply rates was very small. For the degradation problem, non-linear correction was needed in most cases. (Miller-PTT)  
W91-01668

**COMPARISON BETWEEN MEASURED WAVE PROPERTIES AND SIMPLE WAVE HINDCASTING MODELS IN SHALLOW WATER.**  
North Carolina Univ. at Morehead City. Inst. of Marine Sciences.  
For primary bibliographic entry see Field 8B.  
W91-01671

**SCOURHOLE DEVELOPMENTS IN SHALLOW TAILWATER.**  
James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Civil and Systems Engineering.  
For primary bibliographic entry see Field 8B.  
W91-01674

**MODELLING OF SANDWAVE EVOLUTION RESULTING FROM SUSPENDED AND BED LOAD TRANSPORT OF SEDIMENT.**  
Reading Univ. (England). Dept. of Meteorology.  
For primary bibliographic entry see Field 8B.  
W91-01675

**STANDING-WATER DEPOSITS AS INDICATORS OF LATE QUATERNARY DUNE MIGRATION IN THE NORTHWESTERN NEGEV, ISRAEL.**  
Weizmann Inst. of Science, Rehovot (Israel). Dept. of Isotope Research.  
M. Magartiz, and Y. Enzel.  
Climatic Change CLCHDX, Vol. 16, No. 3, p 307-318, June 1990. 5 fig, 1 tab, 27 ref.

Descriptors: \*Dunes, \*Geomorphology, \*Negev Region, \*Paleohydrology, \*Playas, \*Soil water, \*Standing waters, \*Surface-groundwater relations, Drainage systems, Glaciation, History, Israel.

Late Quaternary playa (Stand-water) deposits are present in river channels upstream from dune fields in the northwest Negev, Israel, and represent a drainage disordering caused by dune migration during periods of aridity. These deposits are associated with modifications in the drainage system, including course changes and piracy, caused by dunes blocking drainage networks. Radiocarbon dates from the standing water sediments indicate the occurrence of two periods of aridity: (1) 20,900 to 16,000 years B.P.; and (2) 11,680 to 10,300 years B.P. These two periods indicate a correlation between glacial advances in Europe and dry intervals in the Near East during the Upper Pleistocene. The authors suggest that spatial and temporal associations between standing water deposits, modifications in stream direction, soil formation and the dunes themselves can serve as a good indicator for the timing of dune migration. (Author's abstract)  
W91-01695

**RIVER DISCHARGE AND TIDAL CONTROLS ON SALT-WEDGE POSITION AND IMPLICATIONS FOR CHANNEL SHOALING: FRASER RIVER, BRITISH COLUMBIA.**  
Guelph Univ. (Ontario). Dept. of Geography.  
For primary bibliographic entry see Field 2L.  
W91-01722

**INTERSTITIAL DISSOLVED ORGANIC CARBON IN SEDIMENTS OF A SOUTHERN APPALACHIAN HEADWATER STREAM.**  
Georgia Univ., Athens. Dept. of Zoology.  
For primary bibliographic entry see Field 2H.  
W91-01804

**HILLSLOPE EROSION AT THE MAXEY FLATS RADIOACTIVE WASTE DISPOSAL SITE, NORTHEASTERN KENTUCKY.**  
Geological Survey, Louisville, KY. Water Resources Div.  
W. P. Carey, M. A. Lyverse, and C. R. Hupp.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigation Report 89-4199, 1990. 37p, 11 fig, 11 tab, 20 ref.

Descriptors: \*Erosion rates, \*Geomorphology, \*Kentucky, \*Mass wasting, \*Radioactive waste disposal, Dendrochronology.

Maxey Flats, a disposal site for low level radioactive waste, is on a plateau that rises 300 to 400 ft above the surrounding valleys in northeastern Kentucky. Hillslope gradients average 30% to 40% on three sides of the plateau. The shortest distance from a hillslope to a burial trench is 140 ft on the west side of the site. Rates of hillslope retreat were determined through a combination of direct erosion measurements during the 2-year study and through dendrogeomorphic techniques. Because the dendrogeomorphic rates are average rates during the last 90 years, they were used to estimate the amount of time required for the hillslopes to retreat into the trenches. Rates of hillslope retreat determined from dendrogeomorphic evidence range from 3.8 to 9.1 in/century, so that time to exposure of the trenches ranges from 35,000 to 65,000 years. The minimum estimate of 35,000 years is for the most actively eroding southern slope. Throughout tens of thousands of years, the rate of hillslope retreat is determined more by the occurrence of infrequent extreme events such as slope failure than by the continuous processes of slope wash observed in this study. These slope failures cause as much erosion in one event as hundreds or even thousands of years of slope wash. Periods of tens of thousands of years are also sufficiently long for significant changes in climate and tectonic activity to occur. Rates of erosion observed during this 2-year study are highly unlikely to be indicative of rates averaged over periods of tens of thousands of years during which many extreme events can occur. Thus, the long-term geomorphic stability of the Maxey Flats disposal site will be highly dependent upon the magnitude and frequency of extreme erosive events and upon trends in climate change and tectonic activity. (USGS)  
W91-01831

**SEDIMENT TRANSPORT AND ACCRETION AND THE HYDROLOGIC ENVIRONMENT OF GROVE CREEK NEAR KENANSVILLE, NORTH CAROLINA.**  
Geological Survey, Raleigh, NC. Water Resources Div.  
T. C. Stamey.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4086, 1989. 30p, 10 fig, 6 tab, 12 ref.

Descriptors: \*Grove Creek, \*Hydrologic data, \*North Carolina, \*Sedimentation, Channel improvement, Coastal plains, Drainage, Wetlands.

The Grove Creek basin includes an area of about 42 sq mi in Duplin County, southeastern North Carolina. This report evaluates sediment transport and accretion rates in the lowermost 9-mile reach of Grove Creek using hydrologic, dendrologic, and radioisotopic data collected at seven sites along the study reach. The sediment that is transported in Grove Creek is predominantly silt and clay. Suspended-sediment concentrations at discharges less than 100 cu ft/sec are less than 15 mg/L; concentrations at higher discharges did not exceed 67 mg/L. Calculated suspended-sediment loads ranged from 75 to 444 ton/yr at the various data collection sites on Grove Creek. Sediment accretion rates estimated from dendrologic data ranged from 0.03 to 0.06 ft/yr. The highest accretion rates occur in the downstream swampy reaches and are due to channel braiding, low gradients and flow velocities, and large percentages of overbank flow, which result in the deposition of

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clay and silt over wide areas of the flood plain. Sediment accretion rates along Grove Creek were also estimated by cesium-137 and lead-210 radioisotopic analyses. Sediment cores from the flood plain analyzed for cesium-137 indicate a maximum accretion rate of about 0.024 ft/yr for the period 1952-87. Lead-210 analysis from these same sediment cores indicates an average accretion rate of 0.026 ft/yr to a depth of about 2 ft. The maximum age of the flood-plain sediment at the 2-ft level is about 80 years. (USGS)  
W91-01839

# SEDIMENT-SOURCE DATA FOR FOUR BASINS TRIBUTARY TO LAKE TAHOE, CALIFORNIA AND NEVADA, AUGUST 1983-JUNE 1988.

Geological Survey, Sacramento, CA. Water Resources Div.  
B. R. Hill, J. R. Hill, and K. M. Nolan.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-618, 1990. 42p, 8 fig, 30 tab, 17 ref.

Descriptors: \*California, \*Erosion, \*Lake Tahoe, \*Lake Tahoe Basin, \*Nevada, \*Sediment load, \*Sediment transport, \*Suspended sediments, Sediment discharge, Slope erosion, Stream banks, Stream-channel inventories.

Data were collected during a 5-year study of sediment sources in four drainage basins tributary to Lake Tahoe, California-Nevada. The study areas include the Blackwood Creek, General Creek, Edgewood Creek, and Logan House Creek basins. Data include changes in bank and bed positions at channel cross sections; results of stream-channel inventories; analyses of bank and bed material samples; tabulations of bed-material pebble counts; measured rates of hillslope erosion; dimensions of gullies; suspended-sediment data collected during synoptic snowmelt sampling; and physiographic data for the four study basins. (USGS)  
W91-01847

# EVALUATE A SOIL LOSS PREDICTION MODEL COMBINED WITH AN INFILTRATION MODEL FOR TILLED SOILS.

South Dakota State Univ., Brookings. Dept. of Agricultural Engineering.  
For primary bibliographic entry see Field 2G.  
W91-01861

# SUSPENDED SEDIMENT AND BED LOAD PROBLEMS OF THE UPPER RHINE.

Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).  
For primary bibliographic entry see Field 4D.  
W91-01871

# MINIMUM FROUDE NUMBER AND THE EQUILIBRIUM OF ALLUVIAL SAND RIVERS.

Victoria Univ. of Manchester (England). Dept. of Geography.  
For primary bibliographic entry see Field 2E.  
W91-01874

# CHANNEL SEDIMENT VARIABILITY ALONG A RIVER: A CASE STUDY OF THE SIRET RIVER (ROMANIA).

Statiunea de Cercetari Stejarul, Piatra-Neamt (Romania). Geomorphology Lab.  
For primary bibliographic entry see Field 2E.  
W91-01875

# SOLUTION-COLLAPSE DEPRESSIONS AND SPENSATES IN THE LIMNOCRENIC LAKE OF BANYOLES (NE SPAIN).

Barcelona Univ. (Spain).  
M. Canals, H. Got, R. Julia, and J. Serra.  
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 3, p 243-254, May 1990. 6 fig, 3 tab, 19 ref.

Descriptors: \*Banyoles Lake, \*Geomorphology, \*Karst, \*Lake morphology, \*Limnology, \*Seis-

mology, \*Spain, Geology, Sediments, Seismic properties, Stratification.

A high resolution seismic reflection survey in the Banyoles limnocrenic solution lake allowed penetration of dense suspensates occupying cone-like bottom depressions of different sizes. The depressions result from the dissolution and collapse of underlying Eocene calcareous and gypsiferous materials over which lacustrine sediments of varying thicknesses have accumulated. The suspensates occupying the depressions present three main types of seismic signatures: stratified, semistratified, and transparent. The densities of the suspensates and the water depths of their tops, which fluctuate continuously, vary from one depression to another. The maximum seismically recorded suspensate thickness is 44 meters. Morphological and structural features, seismic characters, and variable degrees of hydraulic activity, point to the existence of different stages of maturity in the lake bottom depressions. Recent instability of the lake bottom and subbottom is apparent in the seismic records, indicating that depression formation processes may continue in a short geological time scale. (Stoehr-PTT)  
W91-01876

# RATES AND MECHANISMS OF DISCONTINUOUS GULLY EROSION IN A RED-BROWN EARTH CATCHMENT, NEW SOUTH WALES, AUSTRALIA.

Soil Conservation Service, Gunnedah (Australia). R. J. Crouch.  
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 3, p 277-282, May 1990. 5 fig, 2 tab, 3 ref.

Descriptors: \*Australia, \*Gully erosion, \*Sediment discharge, \*Sediment yield, \*Soil erosion, Drainage systems, New South Wales, Rainfall, Runoff.

Rainfall, runoff, sediment discharge, and gully expansion were measured for five years in a small catchment in central New South Wales. Sixty percent of the sediment produced from this catchment originated from gully erosion. Gully head erosion was episodic depending on pipe development, cracking, and soil detachment during small runoff events which prepared the heads for rapid soil movement from infrequent large runoff events. On the average each year 5.5 tons of soil were released from the gully heads, 2.5 tons were deposited in the drainage line, and 6.4 tons passed over the weir. In some years very little erosion occurred, in others a large quantity of soil was moved. In this environment erosion from both sources occurred during the same runoff events, particularly after there had been a considerable period of soil detachment with little or no runoff to cause soil movement. In other words, most soil movement occurred in the early stages of some very large runoff events. Soil was detached, both in the gullies and on the ground surface by a variety of mechanisms (soil shrinkage, stock trampling, short duration or low intensity rain) and was then flushed into and along the drainage by large runoff events. (Stoehr-PTT)  
W91-01877

# LONG FLUME STUDY OF THE DYNAMIC FACTORS AFFECTING THE RESISTANCE OF A LOAMY SOIL TO CONCENTRATED FLOW EROSION.

Katholieke Univ. Leuven (Belgium). Lab. voor Experimentele Geomorfologie.  
G. Govers, W. Everaert, J. Poosen, G. Rauws, and J. De Ploey.  
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 5, p 313-328, August 1990. 7 fig, 2 tab, 31 ref.

Descriptors: \*Erosion, \*Flumes, \*Loam, \*Rainfall, \*Rill erosion, \*Runoff, \*Runoff rates, \*Soil compaction, \*Soil erosion, Experimental data, Geomorphology, Infiltration, Sediments, Silt, Soil moisture retention.

Experiments were carried out in a 20 meter long flume to assess the variation of the runoff erosion resistance of a loamy soil as a function of initial

moisture content and compaction. The results of seven experimental runs show that the runoff erosion resistance of a loamy soil is extremely sensitive to variations in initial moisture content and, to a somewhat lesser extent, in bulk density. The very low resistance to runoff erosion of initially dry material is explained by structural changes which take place at the time of wetting. Slaking and microfissuration cause a considerable decrease of the soil's shear strength and therefore of its resistance to runoff erosion. A first analysis shows that, during a given rainfall event, initially dry soils may well show significantly more erosion than initially wet soils, despite the increase of infiltration with decreasing initial moisture content. (Author's abstract)  
W91-01878

# CHANNEL AVULSION AND RIVER METAMORPHOSIS: THE CASE OF THE THOMSON RIVER, VICTORIA, AUSTRALIA.

Melbourne Univ., Parkville (Australia). Dept. of Geography.  
For primary bibliographic entry see Field 2E.  
W91-01879

# DEVELOPMENT OF ARMOUR IN THE TAMBO RIVER, VICTORIA, AUSTRALIA.

Monash Univ., Clayton (Australia). Dept. of Geography.  
D. L. Dunkerley.  
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 5, p 405-412, August 1990. 3 fig, 1 tab, 17 ref.

Descriptors: \*Armoring, \*Bed load, \*Channel armoring, \*Gravel, \*Particle size, \*River beds, \*Sediment transport, \*Sediments, \*Streambeds, Australia, Deposition, Flow characteristics, Scour, Sediment load, Tambo River, Victoria.

Present understanding of armor formation and the dynamics of grain entrainment and movement, especially in natural environments with coarse and poorly-sorted bed material, is still incomplete. There are many details which require further field observation for clarification and hypothesis testing, including aspects of grain interaction during bed-load transport. Evidence from the Tambo River suggests that there may be mechanisms of armor development which have significance in certain field situations but which have been relatively neglected in the literature. The particular mechanism envisaged for the Tambo River involves the accumulation on the bed surface of large clasts which had been moving as an overpassing traction carpet. These clasts are not genetically related to the underlying subarmor sediments, but nonetheless act as an armor which protects them from scour, and which hence affects grain mobility and bed-load transport rates. (Author's abstract)  
W91-01880

# BLANKET PEAT EROSION IN A MID-WALES CATCHMENT DURING TWO DROUGHT YEARS.

University Coll. of Wales, Aberystwyth. Dept. of Geography.  
I. S. Francis.

Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 5, p 445-456, August 1990. 4 fig, 2 tab, 39 ref.

Descriptors: \*Catchment basins, \*Drought, \*Erosion, \*Peat soils, \*Sediment yield, \*Soil erosion, \*Suspended sediments, Organic soils, Runoff, Sediment discharge, Sediment sampling, Stream discharge, Wales.

The rate of blanket peat erosion was measured at an upland site in central Wales during the 1983-1984 drought years. Erosion pins, a peat surface sediment trap, and sediment sampling in the effluent stream, were used to estimate the rate of peat surface recession and the rate of organic sediment loss from the catchment. An overall rate of surface recession of 16 mm per year on exposed peat faces was recorded with the greatest recession on south-west faces. Eroding peat surfaces exhibited maxi-

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### Group 2J—Erosion and Sedimentation

mum recession during the summer, but the peat surface sediment trap indicated that the highest rates of sediment loss from peat faces due to rain wash occurred during the autumn and early winter. Stream sediment sampling showed that the yield of organic sediment from the catchment was 34.4 sq km/yr, with greatest losses also during the autumn and early winter. The evidence suggested that the surface recession, as measured on erosion pins, included a shrinkage component, which might have accounted for as much as 80% of the apparent loss. Direct and circumstantial evidence suggested that peat wastage during the summer months was the most important agent of surface recession in the study period. Desiccation provided available sediment during the autumn, but organic sediment supply became limited as the winter progressed, despite the occurrence of frost heave. (Author's abstract)  
W91-01881

**INFLUENCE OF DEBRIS FLOWS ON CHANNELS AND VALLEY FLOORS IN THE OREGON COAST RANGE, U.S.A.**  
Washington Univ., Seattle. Dept. of Geological Sciences.  
L. Benda.  
Earth Surface Processes and Landforms ESPLDB, Vol. 15, No. 5, p 457-466, August 1990. 6 fig, 22 ref.

Descriptors: \*Aggradation, \*Channel flow, \*Channel morphology, \*Debris flow, \*Detritus, \*Erosion, \*Geomorphology, \*Oregon, \*Sediment erosion, Aggrading rivers, Alluvial channels, Alluvial plains, Bedrock, Channels, Flow characteristics, Gravel, Mountain streams, Sediments.

Debris flows are one of the most important processes which influence the morphology of channels and valley floors in the Oregon Coast Range. Debris flows that initiate in bedrock hollows at heads of first-order basins erode the long accumulated sediment and organic debris from the floors of headwater, first-order and second-order channels. This material is deposited on valley floors in the form of fans, levees, and terraces. In channels, deposits of debris flows control the distribution of boulders. The stochastic nature of sediment supply to alluvial channels by debris flows promotes cycling between channel aggradation which results in a gravel-bed morphology, and channel degradation which results in a mixed bedrock and boulder-bed morphology. Temporal and spatial variability of channel-bed morphology is expected in other landscapes where debris flows are an important process. (Author's abstract)  
W91-01882

**HYDROGRAPHIC SURVEYS AND SEDIMENTATION IN DEEP BAY, HONG KONG.**  
Hong Kong Polytechnic, Kowloon. Dept. of Civil and Structural Engineering.  
S. H. Wong, and Y. S. Li.  
Environmental Geology and Water Sciences EGWSEI, Vol. 15, No. 2, p 111-118, March/April 1990. 5 fig, 2 tab, 5 ref.

Descriptors: \*Bays, \*Hong Kong, \*Hydrography, \*Sediment distribution, \*Sedimentation, \*Sedimentation rates, \*Surveys, \*Suspended solids, Flocculation, Mathematical models, Particle size, Pearl Estuary, Sediment transport, Tides.

Three hydrographic surveys were carried out in Deep Bay, which is located in the eastern part of Pearl estuary between Shenzhen and Hong Kong. Data on current, size distributions of bottom sediment, suspended solids, and some water quality parameters were obtained. This information is of value for mathematical modeling of tidal circulation and sediment transport in the bay, and also useful in the planning of further development in this area. The sedimentation rate in Deep Bay was estimated by two different approaches, comparison of historical navigation maps and Pb210 dating. Information obtained from the maps indicated that the average sedimentation rate between 1898 and 1949 was about 8 mm/yr, while recent years showed a 15 mm/yr sedimentation rate. The average suspended solids concentrations were 10 mg/L

in the wet season survey and 50 mg/L in the dry season survey. There was no significant difference in the size distribution of suspended solids in the vertical direction. The particle size distribution of bottom sediment (composed mostly of silt and clay) was uneven, which is a result of the tidal movement in the estuary. Flocculation is thought to play an important role in sedimentation in Deep Bay. (Stoehr-PTT)  
W91-01883

**REVISED ESTIMATE OF THE LIFE SPAN FOR LAKE NASSER.**  
Florida Univ., Gainesville. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 2H.  
W91-01884

**MUD BALANCE FOR BELGIAN-DUTCH COASTAL WATERS BETWEEN 1969 AND 1986.**  
Rijkswaterstaat, Rijswijk (Netherlands). North Sea Directorate.  
J. S. L. J. Van Alphen.  
Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 1/2, p 19-30, May 1990. 7 fig, 1 tab.

Descriptors: \*Belgium, \*Coastal waters, \*Mud, \*Sediment transport, \*The Netherlands, Erosion, Mud-water interfaces, Sedimentation, Suspended solids.

Mud transport and mud-balances are usually calculated from multiplication of suspended matter concentrations and depth-averaged residual water transport. The results are assumed to underestimate the actual mud transport because the suspended matter concentrations are measured at sea surface, mostly during calm weather. In addition, these kinds of budgets are sensitive to small variations in the estimated residual current velocity. These problems can be overcome by comparing the calculated transports with the fluxes that result from balancing amounts of erosion and deposition. The last figures integrate spatial differences in transport over time to a large extent. Following this approach it is shown that between 1969 and 1986 variations in the mud budget occurred as a result of large-scale human interference (deepening the approach channel to Zeebrugge, closure of Dutch Delta estuaries). The variations were small compared with the annual longshore mud transport, which is dominated by the amount of mud that passes from Dover Strait to Belgian-Dutch waters (c. 8.5 times 10 to the 6th power per year), but were relatively large when compared with the mud transport in the 20 km wide coastal zone. The fluctuations in the annual frequency and duration of gales can cause the annual flux of mud to double in some years. (Author's abstract)  
W91-01934

**SUPPLY AND DEPOSITION OF SEDIMENT ALONG THE NORTH BANK OF HANGZHOU BAY, CHINA.**  
East China Normal Univ., Shanghai. Inst. of Estuarine and Coastal Research.  
B. C. Wang, and D. Eisma.  
Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 3, p 377-390, June 1990. 14 fig, 4 tab, 11 ref.

Descriptors: \*China, \*Hangzhou Bay, \*Sediment distribution, \*Sediment transport, \*Sedimentation, Tidal currents, Tidal flats, Tidal range, Wave direction, Wave height.

Sediment transport and deposition processes were studied on the tidal flats along north Hangzhou Bay (P.R. China) because of the large tidal range, abundant sediment supply and strong seasonal variations. Tidal currents reach a maximum of 8.9 meters per second. The flood is stronger but of shorter duration than the ebb. Waves come from S-SE during the summer (wet season) and from NE-NW during the winter (dry season). Average waves are 40 cm high, but may reach 4 m during storms. Sediment is largely supplied from the Chang Jiang, small amounts also from the Qiantang Jiang. Sediment supply is largest during the winter. The tidal flats consist of clay, silt and some

fine sand; they are 0.6 to 2 km wide. Deposition on the high parts of the flats is enhanced by tidal asymmetry while up-slope transport of sediment is increased by a turbulent front that develops during the flood. Erosion on the flats takes place mainly during summer storms (typhoons), when wave-cut puddles and scarps are formed. In the upper part, vegetation reduces the effect of storms and mainly laminated sediment is present. (Author's abstract)  
W91-01942

**APPLICATIONS OF MAGNETIC MEASUREMENTS TO SEDIMENT TRACING IN URBAN HIGHWAY ENVIRONMENTS.**  
Middlesex Polytechnic, Enfield (England). Urban Pollution Research Center.  
For primary bibliographic entry see Field 5A.  
W91-01997

**HEAVY METALS IN SEDIMENTS OF THE YAMUNA RIVER (A TRIBUTARY OF THE GANGES), INDIA.**  
Oil and Natural Gas Commission, Anklesvar (India).  
For primary bibliographic entry see Field 2K.  
W91-02005

**IRON AND MANGANESE GEOCHEMISTRY AND THE DISTRIBUTION OF 239, 240 PU AND 241 AM IN THE SEDIMENTS OF THE NORTH EAST IRISH SEA.**  
Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Directorate of Fisheries Research.  
For primary bibliographic entry see Field 5B.  
W91-02006

**DISTRIBUTION OF ZINC, LEAD, CADMIUM AND COPPER BETWEEN DIFFERENT SIZE FRACTIONS OF SEDIMENTS I. THE LIMSKI KANAL (NORTH ADRIATIC SEA).**  
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.  
For primary bibliographic entry see Field 5B.  
W91-02009

**DISTRIBUTION OF ZINC, LEAD, CADMIUM AND COPPER BETWEEN DIFFERENT SIZE FRACTIONS OF SEDIMENTS II. THE KRKA RIVER ESTUARY AND THE KORNATI ISLANDS (CENTRAL ADRIATIC SEA).**  
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.  
For primary bibliographic entry see Field 5B.  
W91-02010

## 2K. Chemical Processes

**PRECIPITATION NUTRIENT INPUTS IN SEMIARID ENVIRONMENTS.**  
Agricultural Research Service, Tucson, AZ. Arid-land Watershed Management Research Unit.  
For primary bibliographic entry see Field 2B.  
W91-01030

**BIOGEOCHEMISTRY OF CARBON IN THE AMAZON RIVER.**  
Washington Univ., Seattle. School of Oceanography.  
For primary bibliographic entry see Field 5B.  
W91-01039

**VARIATIONS IN SEDIMENTARY CARBON REMINERALIZATION RATES IN THE WHITE OAK RIVER ESTUARY, NORTH CAROLINA.**  
North Carolina Univ. at Chapel Hill. Inst. of Marine Sciences.  
For primary bibliographic entry see Field 2L.  
W91-01040

**FLUXES AND TRANSFORMATION OF AQUATIC PIGMENTS IN LAKE MENDOTA, WISCONSIN.**

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Wisconsin Univ.-Madison. Water Chemistry Program.  
For primary bibliographic entry see Field 2H.  
W91-01041

**OCEANIC AND ESTUARINE AMMONIUM OXIDATION: EFFECTS OF LIGHT.**  
State Univ. of New York at Stony Brook. Marine Sciences Research Center.  
For primary bibliographic entry see Field 2L.  
W91-01046

**ALGAL USE OF SEDIMENTARY PHOSPHORUS FROM AN AMAZON FLOODPLAIN LAKE: IMPLICATIONS FOR TOTAL PHOSPHORUS ANALYSIS IN TURBID WATERS.**  
California Univ., Santa Barbara. Dept. of Biological Sciences.  
For primary bibliographic entry see Field 2H.  
W91-01047

**ABIOTIC TRANSFORMATIONS OF IRON AND PHOSPHATE IN HUMIC LAKE WATER REVEALED BY DOUBLE-ISOTOPE LABELING AND GEL FILTRATION.**  
Limnologisch Inst., Oosterzee (Netherlands). Tjeu-kemeer Lab.  
For primary bibliographic entry see Field 2H.  
W91-01048

**CONTRIBUTION OF ORGANIC ACIDS TO ALKALINITY IN LAKES WITHIN THE MOUNT ST. HELENS BLAST ZONE.**  
Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.  
For primary bibliographic entry see Field 2H.  
W91-01051

**MERCURY SPECIATION IN SURFACE FRESHWATER SYSTEMS IN CALIFORNIA AND OTHER AREAS.**  
California Univ., Santa Cruz. Inst. of Marine Sciences.  
G. A. Gill, and K. W. Bruland.  
Environmental Science and Technology ESTHAG, Vol. 24, No. 9, p 1392-1400, September 1990. 4 fig, 5 tab, 39 ref.

Descriptors: \*California, \*Chemical speciation, \*Freshwater, \*Geochemistry, \*Mercury, \*Path of pollutants, \*Water chemistry, Bioaccumulation, Chemical analysis, Chemical interactions, Chemical reactions, Fish, Lakes, Rivers, Sediment contamination, Surface water, Suspended sediments, Tissue analysis.

Mercury concentrations and speciation were determined in surface water samples from lakes and rivers in California and other areas. The freshwater systems studied ranged from a pristine alpine lake to a system with Hg-contaminated sediments. Total Hg levels spanned between 2.4 to 500 pM, while dissolved Hg levels ranged from 2 to 60 pM. Dissolved organo-Hg compounds accounted for a majority (up to 89%) of the dissolved Hg in some lakes. Interestingly, those lakes in which highly dissolved organo-Hg levels were observed also had high levels of Hg in fish tissues. A significant portion of the total Hg was usually in the particulate fraction, indicating that suspended particles can be important in influencing Hg cycling in lakes. The total Hg levels obtained, using clean sampling and analytical technologies, were considerably lower than most historical reports. (Author's abstract)  
W91-01063

**VARIABILITY AND DYNAMICS OF LEACHING OF THE FLYSCH CARPATHIAN SLOPE.**  
Polish Academy of Sciences, Krakow. Inst. of Geography and Spatial Organization.  
For primary bibliographic entry see Field 2G.  
W91-01078

**DIURNAL VARIATIONS IN THE INORGANIC SOLUTE CONTENT OF WATER DRAINING FROM AN ALPINE SNOWPATCH.**

Heidelberg Univ. (Germany, F.R.). Geographisches Inst.  
N. Caine.  
Catena, Vol. 16, No. 4/5, p 153-162, August/October 1989. 3 fig, 3 tab, 21 ref.

Descriptors: \*Colorado, \*Diurnal variation, \*Drainage, \*Flow discharge, \*Snowmelt, \*Solute, \*Water chemistry, Solute transport, Water quality.

The results of short-interval sampling of water quality over seven diurnal flow cycles from the Martinielli Basin, site of a long-lasting snowpatch in the Colorado Front Range show an inverse relationship between discharge and the concentration of most solute species. This relationship reflects varying proportions of melt water transferred to the channel through different routes, and suggests that variations in water quality over the diurnal cycle might be used to partition the flow hydrograph. Bias exists in mass yield estimates that are based upon water samples taken with a daily (or longer) interval at the same point in the flow cycle. On the Martinielli site, this bias is less than 5% for most solutes, but is much greater than that in the case of chloride, silicon, and suspended sediments. (Author's abstract)  
W91-01083

**MULTIVARIATE STATISTICAL ANALYSES OF SEDIMENT GEOCHEMISTRY.**  
University of East Anglia, Norwich (England). School of Environmental Sciences.  
For primary bibliographic entry see Field 2L.  
W91-01161

**COPPER TOXICITY TO PARATYA AUSTRALIENSIS: I. INFLUENCE OF NITRILOTRIACETIC ACID AND GLYCINE.**  
Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.  
For primary bibliographic entry see Field 5C.  
W91-01258

**COPPER TOXICITY TO PARATYA AUSTRALIENSIS: II. INFLUENCE OF BICARBONATE AND IONIC STRENGTH.**  
Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.  
For primary bibliographic entry see Field 5C.  
W91-01259

**COPPER TOXICITY TO PARATYA AUSTRALIENSIS: III. INFLUENCE OF DISSOLVED ORGANIC MATTER.**  
Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.  
For primary bibliographic entry see Field 5C.  
W91-01260

**HAILSTONES AS CLOUD WATER COMPOSITION PROBES: AN INITIAL ASSESSMENT.**  
Washington State Univ., Pullman. Lab. for Atmospheric Research.  
L. MacGregor, H. G. Marshall, N. C. Knight, C. A. Knight, and J. C. Farmer.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2247-2251, August 1990. 2 fig, 1 tab, 18 ref.

Descriptors: \*Acid rain, \*Chemical analysis, \*Chemistry of precipitation, \*Cloud liquid water, \*Hail, \*Path of pollutants, Chlorides, Chromatography, Convective precipitation, Nitrates, Nitrites, Oxalates, Sulfates.

This is a preliminary exploration of using hailstones as natural probes of cloud droplet chemistry. Big hailstones grow primarily in the strongest updraft regions of the most severe convective storms, so that if their chemical contents are representative of the cloud droplets from which they grow, they could be useful probes of chemical transport from the lower troposphere to the tropopause, where the anvils form and then evaporate. Results from chromatographic analysis of chloride, nitrate, nitrite, sulfate and oxalate are presented from individual growth layers of hailstones collect-

ed from several different storms. In spite of considerable variability, and the possibility of contamination from the ground, the results appear consistent enough to warrant further investigation of this possible source of data on cloud chemistry. Contamination of hailstone layers, especially on the ground, remains a problem. If this method is to be applied, the hailstones should be caught in nets, and experiments should be done with a hail tunnel to determine the extent of fractionation involved in layer formation, as a function of growth conditions. When hail growth is so wet that it is accompanied by shedding, for instance, then the ice is expected to be purer than cloud water. However, the character of the layers can be used to eliminate those most likely to be misleading. (Lantz-PTT)  
W91-01289

**PRODUCTION AND CARBON ISOTOPIC COMPOSITION OF BACTERIAL CO<sub>2</sub> IN DEEP COASTAL PLAIN SEDIMENTS OF SOUTH CAROLINA.**  
Geological Survey, Columbia, SC. Water Resources Div.  
For primary bibliographic entry see Field 2J.  
W91-01297

**PH AND REDOX BUFFERING MECHANISMS IN A GLACIAL DRIFT AQUIFER CONTAMINATED BY LANDFILL LEACHATE.**  
Western Michigan Univ., Kalamazoo. Center for Water Research.  
For primary bibliographic entry see Field 5B.  
W91-01300

**DECOMPOSITION RATE, CHEMICAL COMPOSITION AND NUTRIENT RECYCLING OF NYMPHAEA ALBA L. FLOATING LEAF BLADE DETRITUS AS INFLUENCED BY PH, ALKALINITY AND ALUMINIUM IN LABORATORY EXPERIMENTS.**  
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.  
For primary bibliographic entry see Field 2H.  
W91-01332

**MICRO-ARTHROPOD SEASONALITY IN STREAMS OF VARYING PH.**  
Queen Mary Coll., London (England). School of Biological Sciences.  
For primary bibliographic entry see Field 2H.  
W91-01339

**DISSOLVED ORGANIC CARBON CONCENTRATIONS AND FLUXES ALONG THE MOISIE RIVER, QUEBEC.**  
University Coll. of North Wales, Bangor. School of Animal Biology.  
T. E. Ford, S. A. Ford, M. A. Lock, and R. J. Naiman.  
Freshwater Biology FWBLAB, Vol. 24, No. 1, p 35-42, August 1990. 2 fig, 2 tab, 25 ref.

Descriptors: \*Canada, \*Dissolved organic carbon, \*Moisie River, \*Quebec, \*Rivers, \*Water chemistry, Abiotic factors, Biotic factors, Conductivity, Hydrogen ion concentration, Optical density, Temperature.

The main stream and tributaries of a 145 km reach of the Moisie River, Quebec, were examined for temperature, conductivity, pH, dissolved organic carbon (DOC), %DOC > 100,000 nominal molecular weight (NMW), optical density (OD350), and the ratio of OD400 to OD600 (E4:E6). Dissolved organic carbon concentrations correlated closely with OD350 ( $r_{sq}=0.92$ ,  $P<0.001$ ). However, %DOC > 100,000 NMW did not correlate with the E4:E6 ratio. Except for a slight increase in %DOC > 100,000 NMW ( $r_{sq}=0.37$ ,  $P<0.05$ ) no change in any characteristic occurred down the length of the Moisie River, despite consistently higher levels of DOC in the tributaries. The results suggest that high concentrations of DOC in tributary waters are rapidly removed within the main river channel. There are a number of mechanisms by which the main channel of a large river can

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influence its dissolved organic matter load. Removal pathways may be biotic (e.g. mineralization by heterotrophic microorganisms) or abiotic (adsorption, precipitation, chemical oxidation or complexation). Only low levels of heterotrophic activity have been measured in boreal rivers relative to temperate rivers with lower DOC, and DOC that has reached the Moisie River might be expected to be microbially recalcitrant. Biotic activity may be responsible for regulating composition of DOC whereas abiotic processes are likely to predominate in regulation of DOC concentration and flux. (White-Reimer-PTT)  
W91-01341

#### **INHIBITORY EFFECTS OF HIGH MOLECULAR WEIGHT DISSOLVED ORGANIC MATTER UPON METABOLIC PROCESSES IN BIOFILMS FROM CONTRASTING RIVERS AND STREAMS.**

University Coll. of North Wales, Bangor. School of Biological Sciences.

C. Freeman, M. A. Lock, J. Marxsen, and S. E. Jones.

Freshwater Biology FWBLAB, Vol. 24, No. 1, p 159-166, August 1990. 1 fig, 3 tab, 24 ref.

Descriptors: \*Biofilms, \*Dissolved organic matter, \*Metabolism, \*Molecular weight, \*Rivers, England, Enzymes, Germany, Inhibitory effects, Phenols.

The effect of removal of organic matter >1000 apparent molecular weight (AMW) on biofilm processes was determined in three contrasting streams in West Germany and three contrasting rivers in the U.K. This process removed 66-85% of the dissolved organic matter supply. Elevations in extracellular enzyme activity (beta-glucosidase, phosphatase and esterase), metabolic heat-output, bacterial density and poly-beta-hydroxy alkanate (PHA) content (a prokaryote storage product) were noted throughout the study in response to the removal of organic matter. This suggests that there are inhibitory substances present in the dissolved organic matter pool >1000 AMW. It is probable that phenolics play a role in this inhibition. Decreases in metabolic heat output, beta-glucosidase activity and PHA content were noted at four sites in response to the removal of >1000 AMW material. The divergent responses of the six river/stream biofilms are indicative of radically differing metabolic/catabolic processes, on a spatial and/or temporal basis, to a major organic supply perturbation. (Author's abstract)  
W91-01345

#### **NITROGEN CYCLING IN LOUISIANA GULF COAST BRACKISH MARSHES.**

Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.

For primary bibliographic entry see Field 2L.  
W91-01351

#### **SEASONAL CHANGES IN THE DISSOLVED FREE AMINO ACID AND DOC CONCENTRATIONS IN A HYPERTROPHIC AFRICAN RESERVOIR AND ITS INFLOWING RIVERS.**

Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology. For primary bibliographic entry see Field 2H.  
W91-01356

#### **EFFECT OF HARDNESS AND SALINITY ON SURVIVAL OF STRIPED BASS LARVAE.**

Maryland Univ. at Baltimore. Dept. of Pathology. For primary bibliographic entry see Field 8I.  
W91-01386

#### **GAS TRANSFER VELOCITIES IN LAKES MEASURED WITH SF<sub>6</sub>.**

University of East Anglia, Norwich (England). School of Environmental Sciences. For primary bibliographic entry see Field 2H.  
W91-01412

#### **SURFACE IONIZATION OF POLYNUCLEAR SPECIES IN ALKALINE HYDROLYSIS—I. TITRATION RESULTS.**

Syracuse Univ., NY. Dept. of Civil and Environmental Engineering. For primary bibliographic entry see Field 5F.  
W91-01413

#### **SURFACE IONIZATION OF POLYNUCLEAR SPECIES IN ALKALINE HYDROLYSIS—II. A CONDITIONAL EQUILIBRIUM MODEL.**

Syracuse Univ., NY. Dept. of Civil and Environmental Engineering. For primary bibliographic entry see Field 5F.  
W91-01414

#### **OXIDATION OF PHENOLS IN WATER BY HYDROGEN PEROXIDE ON ALUMINE SUPPORTED IRON (OXYDATION DES PHENOLS PAR LE PEROXYDE D'HYDROGENE EN MILIEU AQUEUX EN PRESENCE DE FER SUPPORTE SUR ALUMINE).**

Poitiers Univ. (France). Lab. de Chimie de l'Eau et des Nuisances.

N. Al-Hyek, and M. Dore.

Water Research WATRAG, Vol. 24, No. 8, p 973-982, August 1990. 8 fig, 1 tab, 19 ref. English summary.

Descriptors: \*Aluminum, \*Chemical reactions, \*Hydrogen peroxide, \*Iron, \*Oxidation, \*Phenols, \*Wastewater treatment, \*Water treatment, \*Alumina, Aqueous solutions, Catalysts, Chemical interactions, Copper, Spectroscopy, Water chemistry.

In order to specify its reaction mechanism, the oxidation by hydrogen peroxide of phenols in an aqueous medium in the presence of various heterogeneous catalysts and in particular alumina supported iron was studied. The Fenton reactant (H<sub>2</sub>O<sub>2</sub> + Fe(2+)) on phenols and on organic acids was used to compare this system to the catalytic oxidation on a solid catalyst (iron/alumina, iron-copper/alumina) by hydrogen peroxide. The structure of the supported metal was determined by Mossbauer Spectroscopy which established on the one hand the relationships between the structure and the mode of preparation of the catalyst and on the other the modifications of the catalyst surfaces after an oxidation reaction of organic compounds in an aqueous medium. The results showed that the catalytic oxidation of phenol is very weak. In contrast to phenol, polyhydroxybenzenes are readily degraded in heterogeneous catalysis by hydrogen peroxide. The reaction rate is a function on the one hand of the catalytic properties and on the other of the reaction conditions (pH, temperature, presence of bicarbonates in the solution). In general, the reaction rate in heterogeneous catalysis always seems to be a function of the degree of hydroxylation of the organic compounds in contact with the catalyst in the presence of H<sub>2</sub>O<sub>2</sub>. Two types of oxidation mechanisms in heterogeneous catalysis can be envisaged: radical mechanism—the radicals formed by the decomposition of H<sub>2</sub>O<sub>2</sub> on the active sites of the catalyst react with the organic compounds; and non-radical mechanism. (Mertz-PTT)  
W91-01418

#### **PREDICTION OF PHOSPHATE COPRECIPITATION WITH CALCITE IN FRESHWATERS.**

Freshwater Biological Association, Wareham (England). River Lab. For primary bibliographic entry see Field 2H.  
W91-01423

#### **PITFALLS OF SEQUENTIAL EXTRACTIONS.**

Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab. P. M. V. Nirel, and F. M. M. Morel. Water Research WATRAG, Vol. 24, No. 8, p 1055-1056, August 1990. 13 ref.

Descriptors: \*Analytical techniques, \*Sediment analysis, \*Sediment chemistry, \*Separation techniques, \*Trace elements, \*Water analysis, \*Water chemistry, Chemical properties, Data interpretation, Extraction procedures, Kinetics, Physical properties, Sediments.

Sequential extraction procedures consist of subjecting a given sediment sample to a series of increasingly strong reagents under specified conditions. An increasing number of researchers are using sequential extractions to determine the speciation of trace elements in sediments. Unfortunately, sequential extraction methods have not been successfully validated. The results are simply taken as providing operational definitions of the phases one is trying to measure. Sequential extraction procedures do not provide actual particulate speciation. Moreover, the physicochemical conditions used during extraction procedures (strong reagents and fast kinetics) cannot be extrapolated to naturally occurring processes (weak reagents, slow kinetics). Sequential extraction procedures have demonstrated only one incontrovertible distinction among fractions: the residual fraction of trace elements remains unaffected by short-term natural, anthropogenic, or experimental changes in the total element concentrations. It is suggested that it is necessary to elucidate particulate material speciation since it governs geochemical fate and bioavailability of trace elements. However, when a recipe for an extraction procedure is indiscriminately applied to a sediment sample, it is very unlikely that the results have scientific meaning or usefulness. The development and validation of an appropriate analytical method to determine the speciation of trace elements in a sediment sample must precede its application. The necessity that many environmental chemists and geochemists feel to characterize the speciation of trace elements in sediments does not justify using an unvalidated technique or hiding behind operational definitions that have no chemical meaning. (Mertz-PTT)  
W91-01428

#### **COMMENTS ON THE HYDROCHEMICAL REGULATION OF THE HALOGEN ELEMENTS IN RAINFALL, STEMFLOW, THROUGHFALL AND STREAM WATERS AT AN ACIDIC FORESTED AREA IN MID-WALES.**

Institute of Hydrology, Wallingford (England).

For primary bibliographic entry see Field 5B.  
W91-01447

#### **CHEMICAL COMPOSITION AND ACIDITY OF RAINFALL IN THE ALLIGATOR RIVERS REGION, NORTHERN TERRITORY, AUSTRALIA.**

Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).

For primary bibliographic entry see Field 5B.  
W91-01449

#### **CHEMISTRY OF CARBONYL COMPOUNDS IN PO VALLEY FOG WATER.**

Consiglio Nazionale delle Ricerche, Bologna (Italy). Ist. FISBAT.

For primary bibliographic entry see Field 5B.  
W91-01451

#### **RELEASE OF CATIONIC ALUMINIUM FROM ACIDIC SOILS INTO DRAINAGE WATER AND RELATIONSHIPS WITH LAND USE.**

University Coll. of Wales, Aberystwyth. Soil Science Unit.

For primary bibliographic entry see Field 5B.  
W91-01479

#### **SOIL AND SOIL SOLUTION CHEMICAL COMPOSITION AT THREE SITES WITHIN THE LOCH DEE CATCHMENT, SW SCOTLAND.**

Stirling Univ. (Scotland). Dept. of Environmental Science.

I. C. Grieve.

Journal of Soil Science JSSCAH, Vol. 41, No. 2, p 269-277, June 1990. 1 fig, 5 tab, 28 ref.

Descriptors: \*Acid rain, \*Aluminum, \*Ion exchange, \*Leaching, \*Scotland, \*Soil chemistry, \*Soil solution, \*Soil water, \*Solute transport, Acidic soils, Calcium, Geohydrology, Hydrogen

## Chemical Processes—Group 2K

ion concentration, Igneous rocks, Magnesium, Peat soils, Water chemistry.

The interaction of acid deposition with soils has been the subject of considerable interest in the past decade. However, there have been no systematic comparisons of soil water chemistry on different parent materials within catchments. Soil solution chemical composition was monitored over a 2-year period at three plots near the edge of an igneous intrusion in southwest Scotland. Soil solutions were all strongly acidic with a mean pH of approximately 4.0 at 0.20 m depth, and 4.5 at 0.60 m. Chemical composition of the deeper soil solutions varied with geology. Greatest acidity and aluminum concentrations were found over metamorphosed Ordovician sedimentary rocks, with mean pH of 4.3 and Al concentration of 22 mmol/cu m at 0.60 m. At a site on similar rocks nearer the intrusion, mean pH at 0.60 m was 4.8, with very low Al (3 mmol/cu m) and correspondingly greater Ca. At a peaty site on igneous rocks, increased pH with depth was associated with no change in base cations and Al but a reduction in mean SO<sub>4</sub> from 41 mmol/cu m at 0.20 m to 10 mmol/cu m at 0.60 m. Ion-exchange selectivity coefficients calculated from soil and solution chemistry differed slightly from currently used values for peaty upland soils, with larger coefficients for Al/K exchange and smaller coefficients for Al/Ca and Al/Mg exchange. Relations between Al and H ion concentrations confirmed under-saturation of solutions with respect to gibbsite at 0.20 m. The differences between plots were consistent in different seasons, despite significant seasonal variability in Na, Cl, dissolved organic carbon and Fe. (Author's abstract) W91-01480

**LITHIUM IN DRINKING WATER AND THE INCIDENCES OF CRIMES, SUICIDES, AND ARRESTS RELATED TO DRUG ADDICTIONS.** California Univ., San Diego, La Jolla. Dept. of Chemistry. For primary bibliographic entry see Field 5F. W91-01483

**GEOCHEMICAL MODELING OF THE MADISON AQUIFER IN PARTS OF MONTANA, WYOMING, AND SOUTH DAKOTA.** Geological Survey, Reston, VA. L. N. Plummer, J. F. Busby, R. W. Lee, and B. B. Hanshaw. Water Resources Research WRERAQ, Vol. 26, No. 9, p 1981-2014, September 1990. 19 fig, 12 tab, 89 ref.

Descriptors: \*Aquifers, \*Geochemistry, \*Groundwater quality, \*Madison Aquifer, \*Model studies, \*Water chemistry, Carbonates, Dolomite, Groundwater dating, Hydraulic conductivity, Isotope studies, Montana, South Dakota, Stable isotopes, Sulfates, Sulfides, Wyoming.

Stable isotope data for dissolved carbonate, sulfate, and sulfide were combined with water composition data to construct geochemical reaction models along eight flow paths in the Madison aquifer in parts of Wyoming, Montana, and South Dakota. All reaction models reproduce the observed chemical and carbon and sulfur isotopic composition of the final waters and are partially validated by predicting the observed carbon and sulfur isotopic compositions of dolomite and anhydrite from the Madison Limestone. The geochemical reaction models indicate that the dominant groundwater reaction in the Madison aquifer is dedolomitization (calcite precipitation and dolomite dissolution driven by anhydrite dissolution). Sulfate reduction,  $(Ca^{2+} + Mg^{2+})/(Na^{+})$  cation exchange, and halite dissolution are locally important, particularly in central Montana. The groundwater system was treated as closed to CO<sub>2</sub> gas from external sources such as the soil zone or cross-formational leakage but open to CO<sub>2</sub> from oxidation of organic matter coupled with sulfate reduction and other redox processes occurring within the aquifer. Carbon 14 groundwater ages, adjusted for the modeled carbon mass transfer, range from modern to about 23,000 years B.P. and indicate flow velocities of 2.1-26.5 m/yr. Most horizontal hydraulic

conductivities calculated from Darcy's Law using the average 14C flow velocities are within a factor of 5 of those based on digital simulation. The calculated mineral mass transfer and adjusted 14C groundwater ages permit determination of apparent rates of reaction in the aquifer. The apparent rate of organic matter oxidation is typically 0.12 micromol/L/yr. Sulfate and, to a lesser extent, ferric iron are the predominant electron acceptors. The (kinetic) biochemical fractionation of 34S between sulfate and hydrogen sulfide is approximately -44 ppt at 25 C, with a temperature variation of -0.4 ppt/C. The rates of precipitation of calcite and dissolution of dolomite and anhydrite typically are 0.59, 0.24, and 0.95 micromol/L/yr, respectively. (Author's abstract) W91-01517

**SOLUTE TRANSPORT WITH MULTISEGMENT, EQUILIBRIUM-CONTROLLED REACTIONS: A FEED FORWARD SIMULATION METHOD.** Geological Survey, Menlo Park, CA. Water Resources Div. For primary bibliographic entry see Field 5B. W91-01520

**MASS ARRIVAL OF SORPTIVE SOLUTE IN HETEROGENEOUS POROUS MEDIA.** Royal Inst. of Tech., Stockholm (Sweden). For primary bibliographic entry see Field 5B. W91-01521

**STUDY ON GEOCHEMISTRY AND GEOCHEMICAL CLASSIFICATION OF ELEMENTS B, F, RB AND SR IN YELLOW SEA (HUANG HAI) SEDIMENTS.** Academia Sinica, Qingdao (China). Inst. of Oceanology. For primary bibliographic entry see Field 2J. W91-01566

**SODA LAKES ON INNER MONGOLIA PLATEAU, CHINA.** Qinghai Inst. of Salt Lake, Xining (China). For primary bibliographic entry see Field 2H. W91-01574

**EXISTING FORMS OF PHOSPHORUS IN SEDIMENT FROM MIDDLE AND NORTHERN TAIWAN STRAIT (IN CHINESE).** Fujian Inst. of Oceanology, Xiamen (China). For primary bibliographic entry see Field 2L. W91-01575

**MEASUREMENT OF CO<sub>2</sub>-FIXATION IN SEDIMENTS: SOME THEORETICAL AND TECHNICAL ASPECTS.** Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde. For primary bibliographic entry see Field 2J. W91-01586

**CARBON FLUX FROM PHYTOPLANKTON TO FREE-LIVING BACTERIAL DNA.** Shinshu Univ., Matsumoto (Japan). School of Allied Medical Sciences. For primary bibliographic entry see Field 2H. W91-01591

**FATE OF PHYTOPLANKTON PRIMARY PRODUCTION: LOSSES IN RELATION TO BACTERIAL METABOLISM IN A EUTROPHIC SHALLOW LAKE.** Akademie der Wissenschaften der DDR, Berlin. Dept. of Hydrology. B. Nixdorf. Ergebnisse der Limnologie ERLIA6, Vol. 34, p 61-65, 1990. 2 fig, 14 ref.

Descriptors: \*Aquatic bacteria, \*Dissolved organic carbon, \*Eutrophic lakes, \*Limnology, \*Phytoplankton, \*Primary productivity, Algae, Bacterial physiology, Carbon cycle, Germany, Grosser Muggelsee, Radioactive tracers.

In 1987, the carbon flow from phytoplankton to bacteria in a eutrophic shallow lake, Grosser Muggelsee (Berlin), was calculated from measurements of extracellular organic carbon (EOC) release, respiration, and grazing by herbivorous zooplankton. The bacterial production amounted to approximately one half of the primary production and had a similar time course. Net release of EOC due to exudation was smaller than 3% of the particulate primary production. In order to investigate the discrepancy between the relatively high bacterial production and the small amounts of released EOC, the exudate incorporation was estimated by fractional filtration. The radioactivity in the <3 microm fraction was only 3% of the total primary productivity and that in the <12 microm fraction was only 8%. This indicates either a close morphological coupling between algae and bacteria or, in the case of the dominance of suspended bacteria, dissolved organic carbon sources for bacterial production other than phytoplankton exudation. From measurements of algal losses, calculations indicated that an average of 22% of the primary product was respired and 23% was grazed. It was assumed, therefore that a considerable part is lost due to lysis and serves as a carbon source for bacterial production. (Author's abstract) W91-01593

**CLAY, DISSOLVED ORGANIC MATTER, AND BACTERIAL INTERACTIONS IN TWO RESERVOIRS.** Baylor Univ., Waco, TX. For primary bibliographic entry see Field 2H. W91-01600

**NUMBERS AND ACTIVITY OF BACTERIOPLANKTON IN VARIOUS TYPES OF WATERS IN CZECHOSLOVAKIA: RELATIONS TO CHLOROPHYLL CONCENTRATION.** Vyzkumny Ustav Vodohospodarsky, Prague (Czechoslovakia). For primary bibliographic entry see Field 2H. W91-01610

**CONTRIBUTION OF BENTHIC BIOMASS TO OVERALL METABOLISM IN NEW CALEDONIA LAGOON SEDIMENTS.** Museeum National d'Histoire Naturelle, Paris (France). Biologie des Invertebres Marins. For primary bibliographic entry see Field 2L. W91-01659

**SOIL SOLUTION CHEMISTRY OF AN ADIRONDACK SPodosol: LYSIMETRY AND N DYNAMICS.** State Univ. of New York at Syracuse. Coll. of Environmental Science and Forestry. J. P. Shepard, M. J. Mitchell, T. J. Scott, and C. T. Driscoll. Canadian Journal of Forest Research CJFRAR, Vol. 20, No. 6, p 818-824, June 1990. 3 fig, 3 tab, 35 ref. EPRI Integrated Forest Study RP2621-2.

Descriptors: \*Adirondack Mountains, \*Huntington Forest, \*Lysimeters, \*Soil chemistry, \*Soil solution, \*Soil types, \*Soil water, \*Water analysis, \*Water chemistry, Acidity, Ammonia, Calcium, Chemical analysis, Data acquisition, Magnesium, New York, Nitrates, Nitrogen, Spatial variation, Sulfates.

Solutes were monitored from the soil of a beech-maple forest and an adjacent lake at the Huntington Forest in the Adirondack Mountains of New York. The predominant ions were Ca and SO<sub>4</sub>. For soil solutions collected by lysimeters, the highest concentration of most ions (H, NH<sub>4</sub>, Ca, Mg, and NO<sub>3</sub>) occurred in O horizon leachates, and the lowest concentrations beneath the spodic B horizon. However, Al and SO<sub>4</sub> concentrations were highest beneath the B horizon. Concentrations of NO<sub>3</sub> showed distinct seasonal variation. Values reached 60 microequiv/L in the spring and decreased to near zero late in the growing season. Coefficients of variation (CV) differed among horizons. The E horizon was generally the most variable (CV, 17-199%) and the B horizon the least

## Field 2—WATER CYCLE

### Group 2K—Chemical Processes

(CV 19-166%). Variation was especially high for NO<sub>3</sub> and NH<sub>4</sub>, which had minimum CVs of 124% and 122%, respectively. Variation in these ions was likely due to the dominant role of biological processes in affecting nitrogen dynamics. Differences in soil solution concentrations among six soil pits were due to the spatial variation in soil properties rather than differences among the four types of lysimeters (tension, zero tension, fritted glass, and ceramic plate). Nitrogen species showed the greatest response to the installation of lysimeters, with elevated concentrations of NO<sub>3</sub> (120-160 micro equiv/L) observed during the first two years after installation. (Author's abstract)  
W91-01693

#### GC-MS IDENTIFICATION OF GASEOUS VOLATILES IN WASTEWATER.

National Univ. of Singapore. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5A.  
W91-01696

#### ROLE OF AMMONIUM AND NITRATE RETENTION IN THE ACIDIFICATION OF LAKES AND FORESTED CATCHMENTS.

Ontario Ministry of the Environment, Dorchester. Dorset Research Center.  
For primary bibliographic entry see Field 5B.  
W91-01718

#### SPATIAL AND TEMPORAL PATTERNS IN THE HYDROGEOCHEMISTRY OF A POOR FEN IN NORTHERN WISCONSIN.

Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.  
For primary bibliographic entry see Field 2H.  
W91-01720

#### RATE OF DEGRADATION OF 1,1,1-TRICHLOROETHANE IN WATER BY HYDROLYSIS AND DEHYDROCHLORINATION.

Solvay and Cie S.A., Brussels (Belgium). Central Lab.  
For primary bibliographic entry see Field 5B.  
W91-01729

#### FATE OF CATIONIC SURFACTANTS IN THE MARINE ENVIRONMENT, II: PHOTOOXIDATION OF LONG-CHAIN ALKYLAMINES IN AQUEOUS MEDIA.

Centro de Investigación y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-01733

#### KINETIC STUDY OF THE DECOMPOSITION OF METHYL (1-BUTYLCARBAMOYL)-1H-BENZIMIDAZOL-2-YL-CARBAMATE (BENOMYL) TO METHYL 1H-BENZIMIDAZOL-2-YL-CARBAMATE (MBC).

Brock Univ., St. Catharines (Ontario). Dept. of Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-01739

#### MODELING THE FATE AND TRANSPORT OF ORGANIC CONTAMINANTS IN LAKE ST. CLAIR.

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.  
For primary bibliographic entry see Field 5B.  
W91-01792

#### INORGANIC AND ORGANIC GROUND-WATER CHEMISTRY IN THE CANAL CREEK AREA OF ABERDEEN PROVING GROUND, MARYLAND.

Geological Survey, Towson, MD. Water Resources Div.  
For primary bibliographic entry see Field 5B.  
W91-01837

#### GEOLOGY AND GROUND-WATER RESOURCES OF THE MEMPHIS SAND IN WESTERN TENNESSEE.

Geological Survey, Nashville, TN. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01851

#### GROUND-WATER LEVELS, FLOW, AND SPECIFIC CONDUCTANCE IN UNCONSOLIDATED AQUIFERS NEAR LAKE ERIE, CLEVELAND TO CONNEAUT, OHIO, SEPTEMBER 1984.

Geological Survey, Columbus, OH. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01855

#### COMPARING THE EFFECTS OF ACIDIC DEPOSITION ON THE CHEMISTRY OF SMALL STREAMS IN THE SOUTH ISLAND OF NEW ZEALAND WITH THOSE IN THE FICHEL-GEBIRGE, F.R.G.

Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer Hydrologie.  
For primary bibliographic entry see Field 5B.  
W91-01870

#### SPECIFIC CHEMICAL COMPOSITION OF KARST GROUNDWATER IN THE OPHIOLITE BELT OF THE YUGOSLAV INNER DINARIDES: A CASE FOR COVERED KARST.

Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.  
For primary bibliographic entry see Field 2F.  
W91-01885

#### ACIDIFICATION IN NORWAY - LOSS OF FISH POPULATIONS AND THE 1000 LAKE SURVEY 1986.

Norsk Inst. for Vannforskning, Oslo.  
For primary bibliographic entry see Field 5C.  
W91-01889

#### ARE MATHEMATICAL MODELS USEFUL FOR UNDERSTANDING WATER ACIDIFICATION.

Oslo Univ. (Norway). Dept. of Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-01894

#### SUPERCRITICAL FLUID EXTRACTION AND ITS APPLICATION TO ENVIRONMENTAL ANALYSIS.

Mid-Pacific Environmental Lab., Mountain View, CA.  
For primary bibliographic entry see Field 5A.  
W91-01916

#### RAPID METHOD FOR THE SIMULTANEOUS ANALYSIS OF CHLORPYRIFOS, ISOFLUPHOS, CARBARYL, IPRODIONE, AND TRIADIMEFON IN GROUNDWATER BY SOLID-PHASE EXTRACTION.

Massachusetts Pesticide Analysis Lab., Amherst.  
For primary bibliographic entry see Field 5A.  
W91-01917

#### REVERSED-PHASE LIQUID CHROMATOGRAPHIC COLUMN SWITCHING FOR THE TRACE-LEVEL DETERMINATION OF POLAR COMPOUNDS. APPLICATION TO CHLORALLYL ALCOHOL IN GROUNDWATER.

Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Organic-Analytical Chemistry.  
For primary bibliographic entry see Field 5A.  
W91-01918

#### TRACE DETERMINATION OF LOWER VOLATILE FATTY ACIDS IN SEDIMENTS BY GAS CHROMATOGRAPHY WITH CHEMICALLY BONDED FFAP COLUMNS.

Limnologisch Inst., Nieuwersluis (Netherlands).

Vijverhof Lab.

For primary bibliographic entry see Field 5A.  
W91-01919

#### ATMOSPHERIC INPUT OF INORGANIC NITROGEN SPECIES TO THE KIEL BIGHT.

Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.  
For primary bibliographic entry see Field 5B.  
W91-01921

#### PHOSPHATE LIMITATION IN ESTUARINE AND COASTAL WATERS OF CHINA.

British Columbia Univ., Vancouver. Dept. of Botany.  
For primary bibliographic entry see Field 2L.  
W91-01923

#### INCORPORATION OF THYMIDINE, ADENINE AND LEUCINE INTO NATURAL BACTERIAL ASSEMBLAGES.

Vandkvalitetsinstituttet, Hoersholm (Denmark).  
For primary bibliographic entry see Field 2L.  
W91-01931

#### WINTER DISTRIBUTION OF NUTRIENTS IN THE SOUTHERN BIGHT OF THE NORTH SEA (1961-1978) AND IN ESTUARIES OF THE SCHELDT AND THE RHINE/MUESE.

Nederlands Inst. voor Onderzoek der Zee, Texel.  
For primary bibliographic entry see Field 2L.  
W91-01936

#### GAS CHROMATOGRAPHY IN ENVIRONMENTAL ANALYSIS: AIMS AND CHALLENGES.

BASF A.G., Ludwigshafen am Rhein (Germany, F.R.). Aktiengesellschaft labor fuer Umweltanalytik und Okologie.  
For primary bibliographic entry see Field 5A.  
W91-01954

#### TRACE GAS ANALYSIS USING THERMOANALYTICAL METHODS.

Gesamthochschule Wuppertal (Germany, F.R.). Fachbereich 9 - Analytische Chemie.  
For primary bibliographic entry see Field 5A.  
W91-01955

#### GC-FTIR: APPLICATIONS IN ORGANIC TRACE ANALYSIS.

Johannes Kepler Univ., Linz (Austria). Dept. of Analytical Chemistry.  
For primary bibliographic entry see Field 5A.  
W91-01956

#### DETERMINATION OF ORTHO-AND PYROPHOSPHATES IN WATERS BY EXTRACTION CHROMATOGRAPHY AND FLOW-INJECTION ANALYSIS.

Akademiya Nauk SSSR, Moscow. Inst. Geokhimii i Analiticheskoi Khimii.  
For primary bibliographic entry see Field 5A.  
W91-01962

#### HEAVY METALS IN SEDIMENTS OF THE YAMUNA RIVER (A TRIBUTARY OF THE GANGES), INDIA.

Oil and Natural Gas Commission, Anklesvar (India).  
P. K. Jha, V. Subramanian, R. Sitasawad, and R. Van Grieken.  
The Science of the Total Environment STENDL, Vol. 95, p 7-27, June 1990. 10 fig, 6 tab, 45 ref.

Descriptors: \*Geochemistry, \*Heavy metals, \*India, \*Rivers, \*Sediment analysis, \*Sediment distribution, \*Sediment transport, Copper, Iron, Lead, Manganese, Particulate matter, Regression analysis, Yamuna River, Zinc.

Yamuna River sediments are more enriched in metals than those of the Ganges and average

Indian river sediments. Variations of metals in suspended, bed, and core sediment are due to the varying proportions of grain size and mineral content. Iron, manganese and lead show a preference for the oxide fraction, whereas copper and zinc are predominant inorganic and carbonate fractions of sediments. Of the total elemental content, 80 percent manganese, 78 percent iron, 69 percent lead, 67 percent copper and 55 percent zinc are available to chemically mobile phases of the sediments. The high partition coefficient of metals with respect to manganese suggests similar chemical mobility and preferences for solid phases. River sediments in the vicinity of Delhi show an increase in sorption of metals downstream, consequently metals are retained in sediments. The high correlation coefficient and significant regression relation among the metals indicate their similar behavior during transport. At Allahabad, the contribution of the Yamuna to the Ganges is 3200 tons of lead per year, 12,100 tons of zinc per year and 8500 tons of copper per year in particulate form. (Author's abstract) W91-02005

## 2L. Estuaries

### ESTIMATION OF AMMONIFICATION AND AMMONIUM ASSIMILATION IN SURFICIAL COASTAL AND ESTUARINE SEDIMENTS.

Tokyo Univ. (Japan). Ocean Research Inst. T. Sumi, and I. Koike. *Limnology and Oceanography* LIOCAH, Vol. 35, No. 2, p. 270-286, March 1990. 5 fig, 7 tab, 40 ref.

Descriptors: \*Ammonification, \*Ammonium, \*Coasts, \*Estuarine sediments, \*Japan, \*Marine sediments, \*Nutrients, Mathematical analysis, Model studies, Nitrates, Nitrogen cycle, Seasonal variation.

Coastal marine sediments are sites of biological processes closely coupled with nutrient regeneration of deposited organic materials. Ammonification and ammonium assimilation in slurries of surface sediments from Japanese coastal and estuarine areas were studied with  $^{15}\text{NH}_4^+$  tracers. In completely aerobic sediments, where  $\text{NO}_3^-$  reduction is negligible, the Blackburn  $^{15}\text{NH}_4^+$  dilution model can be applied to estimate the ammonification rate after a correction for nitrification is made. In semiaerobic sediments, where significant nitrate reduction occurs, a mathematical model based on the change of  $^{15}\text{NH}_4^+$  and  $^{15}\text{NH}_4^-$  with time was successfully applied to estimate the ammonification rate. The rate of  $\text{NH}_4^+$  assimilation can be obtained directly from the incorporation of  $^{15}\text{NH}_4^+$  into particles in the sediments after correcting for  $^{15}\text{NH}_4^+$  dilution during incubation. The rate of ammonification ranged from 5.8 to 220 ng-atoms N/(g sediment)/h and that of  $\text{NH}_4^+$  assimilation ranged from 6.2 to 114, indicating both large seasonal and local variations. Both  $\text{NH}_4^+$  assimilation and ammonification were significantly correlated with ATP biomass,  $\text{NH}_4^+$ , and organic N contents in sediments. Several lines of evidence also suggested that  $\text{NH}_4^+$  assimilation is primarily an aerobic microbial process. (Author's abstract) W91-01035

### MICROBIAL BIOMASS IN THE COASTAL PLUME OF CHESAPEAKE BAY: PHYTOPLANKTON-BACTERIOPHYTOPLANKTON RELATIONSHIPS.

Maryland Univ., Cambridge. Center for Environmental and Estuarine Studies. T. C. Malone, and H. W. Ducklow. *Limnology and Oceanography* LIOCAH, Vol. 35, No. 2, p. 296-312, March 1990. 11 fig, 5 tab, 61 ref. NSF Grants OCE 84-06526 and OCE 84-06524.

Descriptors: \*Biomass, \*Chesapeake Bay, \*Estuaries, \*Marine bacteria, \*Organic matter, \*Phytoplankton, Carbon cycle, Coastal waters, Copepods, Organic carbon, Predation, Seasonal variation.

Temporal variations in the contributions of phytoplankton and bacterioplankton to the pool of suspended organic matter (POC) were studied in the

coastal plume of Chesapeake Bay. A combination of Eulerian and Lagrangian approaches was used to determine the spatial structure of the plume and to obtain time series of biological properties and rates within the plume. Plume structure was determined from areal surveys (mapping), and time series were conducted while following surface drifters. The turnover rate of POC increased seasonally with temperature as the proportions of POC accounted for by bacterioplankton increased relative to phytoplankton. The proportion of phytoplankton productivity that cycled through bacterioplankton averaged 13% and showed little seasonal variability. These results imply changes in the pathways and rates by which phytoplankton and bacterioplankton production were consumed or exported from the plume. Time series of 1-3 d next to surface drifters within the plume provided some insight into the nature of these changes. In February, when the turnover rate of POC was low, phytoplankton biomass declined relative to bacterioplankton due to sedimentation of large diatoms. Low bacterioplankton biomass was associated with high rates of predation by heterotrophic microflagellates. In August, when POC was turning over rapidly, phytoplankton biomass declined relative to bacterioplankton due to selective grazing by copepods. High bacterioplankton biomass appeared to be a consequence of enhanced DOC flux associated with high copepod grazing and POC turnover rates as well as with low predation by heterotrophic microflagellates. (Author's abstract) W91-01036

### PERIODIC BACTERIVORE ACTIVITY BALANCES BACTERIAL GROWTH IN THE MARINE ENVIRONMENT.

Umea Univ. (Sweden). Dept. of Microbiology. J. Wikner, F. Rassoulzadegan, and A. Hagstrom. *Limnology and Oceanography* LIOCAH, Vol. 35, No. 2, p. 313-324, March 1990. 5 fig, 4 tab, 55 ref.

Descriptors: \*Food chains, \*Marine bacteria, \*Marine environment, \*Predation, Biomass, Diurnal variation, Grazing, Laboratory methods, Organic matter, Protozoa.

Information on spatial and temporal patterns in bacterivory are central to understanding the cycling of organic matter in the sea. The grazing rate of pelagic bacteria was repeatedly determined during 36-h time-course experiments with the microcell recapture technique. Diel variation in the rate of grazing occurred in all water masses investigated. Maximal rates reached 200,000 cells/ml/h, whereas minimal values were 20 times lower. Highest grazing rates were found during the day in most cases, but grazing could also dominate at night as found in one study. Diel periodicity was mainly due to variation in the per-cell feeding rate of bacterivorous flagellates. Accumulation of the bacterial biomass into the 1-3 micron size fraction was positively correlated with changes in bacterial grazing. The transfer efficiency to organisms > 10 microns was low. On average, the daily grazing rate equaled 60% of the bacterial standing stock, exceeding bacterial growth by a factor of 2.6, as estimated from H3-thymidine incorporation. (Author's abstract) W91-01037

### VARIATIONS IN SEDIMENTARY CARBON REMINERALIZATION RATES IN THE WHITE OAK RIVER ESTUARY, NORTH CAROLINA.

North Carolina Univ. at Chapel Hill. Inst. of Marine Sciences. C. A. Kelley, C. S. Martens, and J. P. Chanton. *Limnology and Oceanography* LIOCAH, Vol. 35, No. 2, p. 372-383, March 1990. 8 fig, 3 tab, 43 ref. NASA Grants NAGW-593, NAGW-1455 and NAGW-834.

Descriptors: \*Estuarine sediments, \*Mineralization, \*North Carolina, \*Nutrients, \*Organic carbon, \*River sediments, \*Sediment chemistry, Carbon cycle, Estuarine environment, Macrophytes, Methanogenesis, Microbial degradation, Saline-freshwater interfaces, Sediment analysis, Sulfates.

Rates of microbially mediated sedimentary organic carbon remineralization vary along the salinity gradient of the White Oak River estuary, N.C. A direct comparison of two sites, one upriver dominated by methanogenesis and one downriver dominated by sulfate reduction, indicates a more rapid rate of remineralization upriver. Measurements of diffusive sigma  $\text{CO}_2$  flux plus  $\text{CH}_4$  diffusive (56%) and bubble (44%) fluxes at the upriver freshwater site from June 1986 to March 1988 yield an average yearly flux of  $1.35 \pm 0.35$  mmol/square m/h. At the downriver midestuarine site, the dominant sigma  $\text{CO}_2$  flux for the same period is  $0.46 \pm 0.02$  mmol/square m/h. The uncertainties in these yearly fluxes are calculated from observed ranges in duplicate flux measurements. About 43% of the incoming organic C is remineralized at both sites. The greater remineralization upriver, of which 47% can be attributed to methanogenesis, appears to be supported by rapid decomposition of detritus derived from freshwater, emergent and submersed macrophytes, including *Potamogeton*, *Ceratophyllum*, and *Najas* in surficial sediments. The high organic C content of these upriver sediments may, however, result from the long-term storage of slower degrading plants, such as *Typha* and *Taxodium*. (Author's abstract) W91-01040

### RAPID AMMONIUM CYCLING AND CONCENTRATION-DEPENDENT PARTITIONING OF AMMONIUM AND PHOSPHATE: IMPLICATIONS FOR CARBON TRANSFER IN PLANKTONIC COMMUNITIES.

Texas Univ. at Austin, Port Aransas. Port Aransas Marine Lab. For primary bibliographic entry see Field 2H. W91-01043

### EPISODIC CHANGES IN LATERAL TRANSPORT AND PHYTOPLANKTON DISTRIBUTION IN SOUTH SAN FRANCISCO BAY.

Geological Survey, Menlo Park, CA. L. M. Huzzey, J. E. Cloern, and T. M. Powell. *Limnology and Oceanography* LIOCAH, Vol. 35, No. 2, p. 472-478, March 1990. 5 fig, 23 ref.

Descriptors: \*Coastal waters, \*Estuarine environment, \*Phytoplankton, \*San Francisco Bay, \*Tidal effects, Biomass, Distribution patterns, Nutrients, Seasonal variation, Tidal energy, Wind tides.

Observations in South San Francisco Bay during 1982 showed that substantial cross-channel, nontidal flows accompanied episodic increases in the longitudinal, nontidal flows. Along the channel the nontidal circulation was enhanced during the monthly minima in tidal energy or as a result of wind forcing, producing up-estuary flows 2-3 times greater than normal. These longitudinal pulses modified the horizontal and vertical salinity distributions and generated cross-channel flows of up to 0.07 m/s that persisted for several days. The increased lateral flows were directed to the west and may explain the large fluctuations in phytoplankton biomass observed over the broad eastern shoal during spring. These findings apply to other constituents, such as planktonic larvae, nutrients, or suspended sediments, which also can have large horizontal gradients in estuaries. (Author's abstract) W91-01045

### OCEANIC AND ESTUARINE AMMONIUM OXIDATION: EFFECTS OF LIGHT.

State Univ. of New York at Stony Brook. Marine Sciences Research Center. S. G. Horriggen, and A. L. Springer. *Limnology and Oceanography* LIOCAH, Vol. 35, No. 2, p. 479-482, March 1990. 2 fig, 1 tab, 26 ref.

Descriptors: \*Ammonium, \*Bacterial physiology, \*Chesapeake Bay, \*Nitrification, Biological oxidation, Estuarine environment, Marine bacteria, Marine environment, Nitrogen cycle, Photoinhibition.

Photoinhibition of nitrification has been demonstrated in cultures of soil and marine bacteria as

## Field 2—WATER CYCLE

### Group 2L—Estuaries

well as in field samples from marine environments. The effects of light on the oxidation of ammonium to nitrite by cultures of oceanic and marine bacteria which are ammonium oxidizers were studied. Inhibition of ammonium oxidation by light was more pronounced in the oceanic isolates. The estuarine bacteria, isolated from Chesapeake Bay, produced nitrite at a rate faster than the oceanic isolates. Rates of ammonium oxidation in estuaries are generally greater than those in coastal seas and are much greater than those in the open ocean for several reasons: higher levels of ammonium in estuaries would lead to faster rates of ammonium oxidation; greater turbidity in estuaries decreases light penetration and the particles may provide a substratum for ammonium-oxidizing bacteria; and the shallow depth of most estuaries allows occasional injection of sedimentary bacteria into the water column during major mixing events, which may increase the population of ammonium oxidizers in the water column. The results further indicate that reduced sensitivity to light may be an additional factor contributing to higher rates of ammonium oxidation in estuaries. (Author's abstract) W91-01046

#### PHYTOPLANKTON BIOMASS, PRODUCTION AND GROWTH LIMITATIONS ON THE HUANGHE (YELLOW RIVER) CONTINENTAL SHELF.

Louisiana State Univ., Baton Rouge. Coastal Ecology and Fisheries Inst.  
R. E. Turner, N. N. Rabalais, and Z. Z. Nan.  
Continental Shelf Research CSHRDZ, Vol. 10, No. 6, p 545-571, 22 fig, June 1990. 6 tab, 42 ref.

Descriptors: \*Biomass, \*Coastal waters, \*Growth, \*Huang He River, \*Phytoplankton, \*Productivity, Growth rates, Light intensity, Nitrogen, Nutrients, Phosphorus, Pigments, Population dynamics, Salinity.

Phytoplankton populations were examined in coastal waters of the Huanghe estuary during two cruises in the annual high and normal discharge periods: August 1986 and October 1987, respectively. Strong salinity, nutrient and phytoplankton pigment concentration gradients occur along the 5 m isobath. Landward of these gradients, the phytoplankton growth potential (PGP) appears strongly phosphorus limited, while light limitation of PGP, paradoxically, appears less significant than it does offshore where the euphotic zone depth is greater. Phytoplankton pigments are sparse both in the river and far off shore, and the peak accumulation is centered broadly between 20 and 25 ppt, thus straddling the region of the hypopycnal plume from the hypopycnal plunge point to where Secchi disk depth exceeds 1 m. As the suspended matter falls out (sharply) near the 25 ppt isohaline, light conditions improve, the N:P ratio drops to below 100, and nitrate concentrations continue to decrease in an offshore direction. Phytoplankton production rates reach a maximum, and large algal cells accumulate, where the suspended particulate matter concentration drops to less than 10 mg/L. Both phytoplankton biomass production declines beyond approximately 32 ppt. Sedimentary pigment accumulations increase going from land to sea. Phosphorous and nitrogen dominate the suite of nutrients tested to determine which nutrients limit PGP. Phosphorous is probably the major nutrient limiting phytoplankton growth (not necessarily biomass accumulation) in most of the Huanghe estuary. This conclusion is based on the very high N:P ratios of dissolved nutrients, the results of an extensive array of addition and deletion bioassay experiments, and the results of P addition experiments. Where trace metals and EDTA limit PGP, they are usually limiting in concert with other nutrients and do not act alone. Comparison with other large river plumes are made. (Author's abstract) W91-01058

#### HYDRODYNAMIC MODEL FOR WIND-DRIVEN AND TIDAL CIRCULATION IN THE ARABIAN GULF.

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Water Resources and Environment Div.

A. H. Al-Rabeh, N. Gunay, and H. M. Cekirge.  
Applied Mathematical Modelling AMMODL, Vol. 14, No. 8, p 410-419, August 1990. 8 fig, 2 tab, 57 ref.

Descriptors: \*Arabian Gulf, \*Hydrodynamics, \*Hydrologic models, \*Mathematical models, \*Tidal currents, \*Wind-driven currents, Eddies, Topography, Water circulation, Water currents, Wind velocity.

The vertical/horizontal splitting (VHS) model was extended and adapted to simulate tidal and wind-driven circulation in the Arabian Gulf. The extensions included the use of finite differences for the depth-averaged equations, the use of the depth following coordinate in the vertical, and relating the bottom friction to the bottom velocity. The VHS model was adapted to the Persian Gulf (Arabian Gulf) using two implementations. The first, HYDRO1, simulated wind-driven and/or tidal circulation in the Arabian Gulf. A two-block grid system in cartesian coordinates was used with a finer grid on the western coast of the gulf. The second, HYDRO2, simulated wind-driven and/or tidal circulation in any user-defined area in the Arabian Gulf. HYDRO2 enables the user to study in detail a specific region of interest in the gulf. HYDRO2 was used to simulate tidal and wind-driven circulation in the region of Abu Ali, represented by a 10 by 10 grid with a grid size of approximately three km. A northwesterly synthetic wind with a maximum speed of 10 m/sec was applied. Wind direction was considered constant, and wind speed was computed as a Gaussian function of time. Both implementations carry out three-dimensional computation when the conventional two-dimensional hypotheses are locally inadequate and when specified by the user. Elsewhere, two-dimensional computation is employed. Implementation and testing details include specification of appropriate eddy viscosity profile, wind drag coefficient, and Chezy coefficient. (Brunone-PTT) W91-01077

#### PROCESSES GOVERNING MARSH FORMATION IN A RAPIDLY SUBSIDING COASTAL ENVIRONMENT.

Louisiana State Univ., Baton Rouge. Center for Wetlands Research.  
R. D. DeLaune, W. H. Patrick, and N. Van Breeman.  
Catena, Vol. 17, No. 3, p 277-288, June 1990. 4 fig, 2 tab, 23 ref.

Descriptors: \*Coastal marshes, \*Deltas, \*Mississippi River, \*Salt marshes, \*Subsidence, \*Wetlands, Accretion, Decomposing organic matter, Oxidation, Plant growth, Plant nutrients, Plant physiology, Sediments, Soil compaction, Water level fluctuations.

Processes governing the stability of marshes in Louisiana's Mississippi River delta plain were examined. An accretionary budget was developed for Barataria Basin fresh, brackish-intermediate, and salt marshes located along a salinity gradient extending inland from the coast. The marshes represent a thin veneer overlying sediment strata deposited by the Mississippi River and its predecessors. At many location rates of vertical marsh accretion were not sufficiently rapid to keep pace with increased water depth accompanying rapid subsidence due to compaction. The life span of salt marshes of the Mississippi River deltaic plain are estimated to be approximately 100 years. The mineral sediment and organic carbon requirement of individual marsh units in response to water level was determined. Organic matter is an important component of accretionary processes and helps the marsh surface to keep pace with water level increases. An estimated 600 to 700 g of carbon/sq m per year must be supplied to maintain marsh accretion to balance soil oxidation-decomposition losses and organic carbon accretion (peat formation). Even though subsidence is the primary factor in marsh deterioration, accompanying factors (soil water intrusion, excess waterlogging) stress vegetation and thus reduce the organic carbon source below minimum aggradation requirements. Inorganic sediment input is also necessary for maintenance of viable marshes. Many of the marshes

within the basin are not receiving sufficient nutrients from sediment sources to maintain significant plant growth necessary for organic matter production. Barataria Basin marsh will likely continue disappearing unless means are implemented for re-introducing sediment from the Mississippi River. (Author's abstract) W91-01088

#### DIRECT IMPACTS OF OUTER CONTINENTAL SHELF ACTIVITIES ON WETLAND LOSS IN THE CENTRAL GULF OF MEXICO.

Louisiana State Univ., Baton Rouge. Center for Energy Studies.

R. H. Baumann, and R. E. Turner.  
Environmental Geology and Water Sciences EGWSEI, Vol. 15, No. 3, p 189-198, May/June 1990. 2 fig, 6 tab, 13 ref.

Descriptors: \*Continental shelf, \*Gulf of Mexico, \*Louisiana, \*Resource management, \*Wetlands, Aerial photography, Field surveys, Navigation canals, Pipelines, Right-of-way.

The direct impacts of outer continental shelf (OCS) development on recent wetland loss in the northern Gulf of Mexico were quantified using aerial imagery, field surveys, and literature review. The total direct impacts accounted for an estimated 25.6% of total net wetland loss within the Louisiana portion of the study area from 1955/1956 to 1978. Of the total direct impacts of 73,905 ha, OCS-related activities accounted for 11,589 to 13,631 ha of the wetland loss during the same interval. Although this is a substantial areal loss, it represents only 4.0 to 4.7 percent of the total Louisiana wetland loss from 1955/1956 to 1978, and 15.7 to 18.4 percent of direct impacts. Direct impacts from OCS pipelines averaged 2.49 ha/km, lower than published guidelines, and totaled 12,012 ha. Lowest impacts are for backfilled pipelines in the Chenier Plain of western Louisiana and for small young pipelines built in clustered rights-of-way. Widening of OCS pipeline canals does not appear to be an important factor for total net wetland loss in the coastal zone because few pipelines are open to navigation and, for the examples found, the impact width was not significantly different than for open pipelines closed to navigation. Navigation channels account for a minimum of 16,902 ha of habitat change. Direct impacts per unit length of navigation channel average 20 times greater than pipelines. (Author's abstract) W91-01099

#### ENVIRONMENTAL EVALUATION PROCEDURE FOR COASTAL DEVELOPMENTS IN SOUTH AFRICA.

Cape Town Univ. (South Africa). Environmental Evaluation Unit.  
For primary bibliographic entry see Field 6B. W91-01122

#### LONGITUDINAL DISPERSION PROCESSES IN THE UPPER TAMAR ESTUARY.

Birmingham Univ. (England). Dept. of Civil Engineering.  
J. R. West, R. J. Uncles, J. A. Stephens, and K. Shiono.  
Estuaries ESTUDO, Vol. 13, No. 2, p 118-124, June 1990. 5 fig, 25 ref.

Descriptors: \*Dispersion, \*Estuaries, \*Salinity, \*Sediment transport, \*Solute transport, \*Tamar Estuary, \*Tidal hydraulics, Saline-freshwater interfaces, Suspended sediments, Temporal distribution.

Measurements of velocity, salinity, and suspended solids concentration across a section of the upper Tamar Estuary for a spring and neap tidal cycle have been used to investigate the intra-tidal variation of vertical and transverse shear-induced dispersion. The interaction of vertical shear and longitudinal salinity-induced gradient leads to fairly well-mixed flood tide conditions and stable ebb tide conditions. Sediment transport is associated with active vertical momentum transport; the dispersive flux is generally <10% of the advective flux. The dispersive particulate flux is landward

during the ebb and seaward during the flood; the tidal average dispersal is very small compared with tidal average advective effects. The fluvial and dispersive fluxes of solute are approximately equivalent; the solute dispersive flux is important for the study of salinity intrusion problems. The transverse shear solute dispersion coefficient was found to be about 10% of the maximum values of vertical shear dispersion coefficient. The tidal pumping mechanism is a significant contribution to tidally averaged fluxes in the upper reaches of estuaries and are probably inappropriate where tidal range is greater than low water depth. The asymmetry of the temporal variation may be used to postulate causative mechanisms for landward and seaward fluxes that have previously been suggested as evidence of gravitational circulation effects. (See also W91-01129) (Author's abstract)  
W91-01127

#### TIDAL STRAINING, DENSITY CURRENTS, AND STIRRING IN THE CONTROL OF ESTUARINE STRATIFICATION.

University Coll. of North Wales, Menai Bridge, Marine Science Labs.  
J. H. Simpson, J. Brown, J. Matthews, and G. Allen.  
Estuaries ESTUDO, Vol. 13, No. 2, p 125-132, June 1990. 6 fig, 16 ref.

Descriptors: \*Density currents, \*Density stratification, \*Estuaries, \*Stratification, \*Tides, Buoyancy, Liverpool Bay, Saline-freshwater interfaces, Stirring.

Buoyancy input as fresh water exerts a stratifying influence in estuaries and adjacent coastal waters. Predicting the development and breakdown of such stratification is an inherently more difficult problem than that involved in the analogous case of stratification induced by surface heating because the buoyancy input originates at the lateral boundaries. In the approach adopted here, the energy considerations were used in the surface heating problem to describe the competition between the stabilizing effect of fresh water and the vertical mixing brought about by tidal and wind stirring. Freshwater input induces horizontal gradients which drive the estuarine circulation in which lighter fluid at the surface is moved seaward over heavier fluid moving landward below. This contribution to stratification is expected to vary in time as the level of turbulence varies over the tidal cycle. The density gradient also interacts directly with the vertical shear in the tidal current to induce a periodic input to stratification which is positive on the ebb phase of the tide. Comparison of this input with the available stirring energy leads to a simple criterion for the existence of strain-induced stratification. Observations in a region of Liverpool Bay satisfying this criterion confirm the occurrence of a strong semidiurnal variation in stratification with complete vertical mixing apparent around high water except at neap tides when more permanent stratification may develop. A simulation of the monthly cycle based on a model including straining, stirring, and the estuarine circulation is in qualitative agreement with the main features of the observations. (Author's abstract)  
W91-01128

#### COMPUTED AND OBSERVED CURRENTS, ELEVATIONS, AND SALINITY IN A BRANCHING ESTUARY.

Plymouth Marine Lab. (England).  
R. J. Uncles, and J. A. Stephens.  
Estuaries ESTUDO, Vol. 13, No. 2, p 133-144, June 1990. 7 fig, 1 tab, 23 ref.

Descriptors: \*Dispersion, \*Estuaries, \*Saline-freshwater interfaces, \*Salinity, \*Salt balance, \*Tidal hydraulics, Seasonal variation, Tamar Estuary.

A one-dimensional, hydrodynamical model of the Tamar Estuary shows good agreement with measured tidal elevations and currents. Computed currents are used to drive a one-dimensional, moving-element model of the salt balance. The moving-element model overcomes the numerical difficulties associated with strong tidal advection. Axial

distributions of salinity at high water, computed using the moving-element model, compare well with measurements. The modelled and observed high water salinity distributions in this macrotidal estuary show little dependence on tidal range. The major variability in salinity is due to runoff. This strong and rapid dependence on runoff is a consequence of short residence (or flushing) times. Typically, residence times are less than one day throughout the year in the upper 10 km of estuary. The residence times maximize in summer, reaching 14 d for the whole estuary. During high runoff winter periods residence times are less than 5 d. Mixing coefficients for the moving-element salinity model are deduced from salinity measurements. Dispersion coefficients at fixed locations along the estuary are deduced from solutions of the salinity model. The spatially-averaged coefficients at mean spring and neap tides are 180 and 240 sq m/s, respectively, for average runoff. Therefore, spring-neap variations in dispersion are fairly small and show a negative correlation with tidal range. The spatially-averaged dispersion coefficients at mean tides vary from 150 to 300 sq m/s for typical summer and winter runoff, respectively. The increase in dispersion with runoff and the decrease with tidal range implies that buoyancy-driven currents generate an important component of the shear dispersion in this estuary. (See also W91-01127) (Author's abstract)  
W91-01129

#### SALINITY STRATIFICATION IN A RIVER-DOMINATED ESTUARY.

Alabama Marine Resources Lab., Dauphin Island, W. W. Schroeder, S. P. Dinnel, and W. J. Wiseman.  
Estuaries ESTUDO, Vol. 13, No. 2, p 145-154, June 1990. 8 fig, 1 tab, 38 ref. DOC NOAA Office of Sea Grant No. NA81AA-D-0050 (Project R/ER-14PD).

Descriptors: \*Estuaries, \*River flow, \*Saline-freshwater interfaces, \*Salinity, \*Stratification, Alabama, Mobile Bay.

Analysis of salinity data from Mobile Bay indicates that stratification-destratification events within this broad, shallow estuary are not uncommon. These events are related to the strength of the winds, through their influence on wave generation and subsequent bottom drag coefficient increases, and to the strength of river discharge. They do not appear to be due to the strength of tidal currents, as has been observed elsewhere. Furthermore, river flow appears to be the dominant control, the winds being important only in the absence of large freshwater discharges. The annual spring freshet can flush most of the salt from the bay. During other times of the year the relative strengths of river discharge and wind stress change the bay from highly stratified to nearly homogeneous and back on a variety of time scales ranging from daily to seasonal. (See also W91-01130) (Author's abstract)  
W91-01130

#### TEMPORAL VARIABILITY OF REMOTELY SENSED SUSPENDED SEDIMENT AND SEA SURFACE TEMPERATURE PATTERNS IN MOBILE BAY, ALABAMA.

New Orleans Univ., LA. Center for Research in Ocean and Space Sciences.  
J. B. Rucker, R. P. Stumpf, and W. W. Schroeder.  
Estuaries ESTUDO, Vol. 13, No. 2, p 155-160, June 1990. 5 fig, 9 ref. DOC NOAA Office of Sea Grant No. NA81AA-D-0050 (Project R/ER-14PD).

Descriptors: \*Estuaries, \*Mobile Bay, \*Remote sensing, \*River discharge, \*Suspended sediments, \*Temperature, Alabama, Infrared imagery, Satellite technology, Temporal variation.

Distribution patterns of suspended sediments and sea surface temperatures in Mobile Bay were derived from algorithms using digital data from the visible, near infrared, and infrared channels of the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA-TIROS-N satellite. Closely spaced AVHRR scenes for January 20, 24,

and 29, 1982, were compared with available environmental information taken during the same period. A complex interaction between river discharge, winds, and astronomical tides controlled the distribution patterns of suspended sediments. These same variables, coupled with air temperatures, also governed the distribution patterns of sea surface temperatures. (See also W91-01130) (Author's abstract)  
W91-01131

#### DETERMINATION OF THE ORIGIN OF SUSPENDED MATTER AND SEDIMENTS IN THE ELBE ESTUARY USING NATURAL TRACERS.

Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.  
J. H. Schoer.  
Estuaries ESTUDO, Vol. 13, No. 2, p 161-172, June 1990. 11 fig, 2 tab, 34 ref.

Descriptors: \*Carbonates, \*Elbe Estuary, \*Estuaries, \*Sediment transport, \*Suspended load, \*Suspended sediments, \*Suspended solids, \*Tracers, Clays, Hafnium, Kaolinite, Saline-freshwater interfaces, Zircon.

The clay mineral composition, the concentrations of carbonates, the proportions of carbon and oxygen isotopes in carbonates and organic matter, as well as the concentrations of different nonanthropogenic metals were used to determine the origin of different grain size fractions of sediments and suspended matter in the Elbe estuary. Analysis of the smectite/kaolinite proportion revealed that solid material  $< 2$  micron from the North Sea is transported up the river, about 40 km beyond the most upstream position of the salt wedge. In the 2-20 micron fraction, the 160/180 ratio in carbonates and the kaolinite/chlorite proportion demonstrate a transport of North Sea material between 40 and 20 km upstream of the marine water limit. The transport behavior of the 20-63 micron grain size fraction could be determined by the hafnium concentration, representative for the heavy mineral zircon. In this case, the transport distance beyond the salt wedge was up to 20 km. No information was available on the origin of the fine organic matter, whereas the coarser fractions were derived primarily from debris of salt marsh vegetation. The results demonstrate that in the Elbe estuary mixing between marine and fluvial solid material occurs upstream of the salt wedge and is significantly responsible for the observed decrease in the concentration of various pollutants in sediments and suspended matter along the estuary. The cause of the upstream particle transport is probably a scour lag mechanism based on asymmetries of the flood-tide and ebb-tide current distribution, especially their differing maximum velocities. (Author's abstract)  
W91-01132

#### MACROINFAUNAL COMMUNITY OF A TROPICAL ESTUARINE LAGOON.

Center for Energy and Environment Research, Mayaguez, PR.

A. W. Stoner, and C. Acevedo.  
Estuaries ESTUDO, Vol. 13, No. 2, p 174-181, June 1990. 4 fig, 5 tab, 40 ref. NOAA Office of Sea Grant No. R/A-01-2 and NSF Grant No. R-II-8610677.

Descriptors: \*Benthic fauna, \*Coastal lagoons, \*Estuaries, \*Estuarine environment, \*Puerto Rico, \*Species composition, \*Tropical regions, Laguna Joyuda, Oligochaetes, Polychaetes, Seasonal variation.

The benthic macroinfauna of Laguna Joyuda, a coastal lagoon in Puerto Rico, was surveyed for two years. Seven hundred fifty core samples yielded 23 macrobenthic taxa. The oligochaete *Thalassodrilus gurwitschi* comprised 43.4% of the number of individuals collected. Polychaetes comprised 35.4% of the individuals, including *Capitella* cf. *capitata*, *Dasybranchus lumbricoides*, and *Stenonereis martini* in approximately equal numbers. The amphipod *Grandierella bonnieroides* made up 11.5% of the community. The lagoon yielded fewer species than other tropical estuaries in the

## Field 2—WATER CYCLE

### Group 2L—Estuaries

Caribbean and Atlantic, but the trophic composition, mostly deposit feeders, was similar. Seasonal patterns in the abundance of individuals were most pronounced in the central basin, with maximum number of organisms during the wet season, and a minimum in the dry season. Responses to rainfall events, however, were variable and probably related to migration patterns in predators. Macrofaunal biomass demonstrated a high degree of annual variation at all sampling stations with a marked increase in 1987. Low macrofaunal biomass, lack of temporal association with physical-chemical conditions, and inverse relationships with predator populations suggest that patterns of macrofaunal abundance in Laguna Joyuda are mediated primarily by biotic mechanisms. (Author's abstract) W91-01133

**STRUCTURE AND FUNCTION OF DRY WEATHER MANGROVES ON THE PACIFIC COAST OF CENTRAL AMERICA, WITH EMPHASIS ON AVICENNIA BICOLOR FORESTS.** Universidad Nacional Autónoma de Heredia (Costa Rica). Escuela Ciencias Biológicas. J. A. Jimenez. Estuaries ESTUDO, Vol. 13, No. 2, p 182-192, June 1990. 7 fig, 24 tab, 25 ref.

Descriptors: \*Central America, \*Mangrove swamps, \*Semi-arid climates, \*Wetlands, Coastal areas, Rainfall, Runoff, Soil water.

Mangrove forests along the Pacific Coast of Central America cover around 4,000 sq km. Most of this coast is occupied with tropical dry forest mangroves where basal areas range between 6 and 20 sq m/ha and canopy heights rarely exceed 20 m. Rainfall and runoff alter structure and floristic composition from site to site. Reproductive phenology and mortality appear to be related to soil water availability. Avicennia bicolor forests reach a density of 4,350 plants that are taller than 0.50 m/ha, with 769 trees above 5 cm diameter at breast height. A total basal area of 41 sq m/ha together with a canopy height of about 23 m place these forests among the most developed in the western hemisphere. Growth rate (0.38 sq m/ha/yr) is surprisingly high for mangrove forests under a seasonal dry climate. (Author's abstract) W91-01134

**CANANEIA LAGOON ESTUARINE SYSTEM, SAO PAULO, BRAZIL.** Sao Paulo Univ. (Brazil). Inst. Oceanografico. Y. Schaeffer-Novelli, H. S. L. Mesquita, and G. Cintron-Molero. Estuaries ESTUDO, Vol. 13, No. 2, p 193-203, June 1990. 2 fig, 50 ref.

Descriptors: \*Coastal lagoons, \*Estuaries, \*Estuarine environment, \*Mangrove swamps, \*Subtropical zone, Brazil, Photosynthesis, Primary production, Water budget.

The Cananeia Lagoon estuarine system lies at 25 degrees S, near the latitudinal limit for mangroves. It is 110 km long, consisting of 1-3 km wide channels behind a barrier island, with narrow inlets at the southern and northern ends. Average and maximum depths are 6 m and 12 m. The system is microtidal and subtropical. Mean annual temperature is 21.4 degrees C (annual amplitude = 7.0 degrees C). When the area receives sporadic frosts, temperatures close to 2 degrees C occur in the estuary. Annual precipitation (2,270 mm) exceeds annual potential evapotranspiration (1,656 mm). The water budget of the 1,339 sq km watershed is controlled primarily by local rainfall. Before 1978, a large river discharged a significant portion of its flow into the lagoon, but closure of the diversionary channel has since caused changes in salinity, phytoplankton populations, and mangrove coverage. About 90 sq km of intertidal habitat is occupied by mangroves and tidal marsh; mangroves are dominant. Fringe and riverine forests (dominated by Rhizophora) are more structurally developed than the basins dominated by Laguncularia and have higher litterfall rates (2.08 g/sq m/d, fringes; 1.04 g/sq m/d, basins). Primary production exhibits pronounced seasonal pulses; heterotrophic processes lag photosynthetic production and are par-

tially driven by particulate matter inputs. Synthetic models must consider the spatial and temporal heterogeneity of this region. (Author's abstract) W91-01135

**VARIABILITY OF MANGROVE ECOSYSTEMS ALONG THE BRAZILIAN COAST.** Sao Paulo Univ. (Brazil). Inst. Oceanografico. Y. Schaeffer-Novelli, G. Cintron-Molero, R. R. Adaime, and T. M. de Camargo. Estuaries ESTUDO, Vol. 13, No. 2, p 204-218, June 1990. 15 fig, 34 ref.

Descriptors: \*Brazil, \*Coastal areas, \*Forest ecosystems, \*Mangrove swamps, Climates, Distribution patterns, Evapotranspiration.

Brazilian mangroves extend from 4 degrees 30 min N to 28 degrees 30 min S, varying greatly in growth form, species distribution patterns, and stand structure, in spite of a limited floristic diversity. The Brazilian coastline was divided into eight units, within which physiographic and climatic conditions are relatively uniform, and described mangrove occurrence, species distribution and structural attributes characteristic of each segment. In general, greatest mangrove coverage and greatest forest stature are found in area with a large surplus of rainfall over potential evapotranspiration and macrotidal regimes. An exception was the segment containing the mouth of the Amazon river, where freshwater systems dominate over brackish or marine associations. The variability in species associations and the dominance of each in a given environment is predominantly determined by the characteristics of the landforms that can be colonized by each species in a given region. The type, size, and frequency of occurrence of available landforms is a function of the particular mix of fluvial, tidal, and wave energies found in a region. Different species colonize these sites depending on their adaptations and edaphic preferences. Climate affects mangrove colonization and growth. It is suggested that Brazilian mangroves play a minor role in modifying the geomorphic setting; the spatial arrangement of the various forest types is a response to the underlying topography and edaphic conditions, and to the constraints imposed by climatic and hydrologic factors. The spatial arrangement of species does not necessarily show successional processes, but may be the result of direct and differential colonization on appropriate substrates. (Author's abstract) W91-01136

**MANGROVE ECOLOGY, AQUATIC PRIMARY PRODUCTIVITY, AND FISH COMMUNITY DYNAMICS IN THE TEACAPAN-AGUA BRAVA LAGOON-ESTUARINE SYSTEM (MEXICAN PACIFIC).** Universidad Nacional Autónoma de Mexico, Mexico City. Inst. de Ciencias del Mar y Limnología. For primary bibliographic entry see Field 2H. W91-01137

**TEST OF THE ASSUMPTIONS AND PREDICTIONS OF RECENT MICROALGAL GROWTH MODELS WITH THE MARINE PHYTOPLANKTON PAVLOVA LUTHERI.** Hawaii Univ., Honolulu. Dept. of Oceanography. M. S. Chalup, and E. A. Laws. Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 583-596, May 1990. 11 fig, 2 tab, 50 ref. Solar Energy Research Institute Subcontract XK-4-04109.

Descriptors: \*Algal growth, \*Marine algae, \*Model studies, \*Phytoplankton, Carbon, Chlorophyll a, Irradiation, Nitrogen, Nutrients.

The marine phytoplankton Pavlova lutheri was grown in both batch and continuous culture under various conditions of light and nitrate limitation in order to examine the accuracy of certain assumptions and predictions of microalgal growth models. The N:C ratio of the cells was found to be uniquely related to their relative growth rate. There was no unique relationship, however, between Chl a:C ratios and relative growth rate. Optical absorption

coefficients normalized to Chl a were negatively correlated with relative growth rate at a fixed irradiance and positively correlated with irradiance at a fixed relative growth rate when light intensity was varied with neutral-density filters. Quantum yields were positively correlated with relative growth rate at a fixed irradiance and negatively correlated with irradiance at a fixed relative growth rate. Certain parameters or combinations of parameters which appear in nutrient-saturated growth models were found to be either independent of relative growth rate at a fixed irradiance or uniquely correlated with relative growth rate. This discovery facilitates extension of nutrient-saturated growth models to nutrient-limited conditions. (See also W91-01140) (Author's abstract) W91-01139

**MICROALGAL GROWTH MODEL.** Hawaii Univ., Honolulu. Dept. of Oceanography. E. A. Laws, and M. S. Chalup. Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 597-608, May 1990. 7 fig, 1 tab, 29 ref. Solar Energy Research Institute Subcontract XK-4-04109.

Descriptors: \*Algal growth, \*Limiting nutrients, \*Limnology, \*Model studies, \*Photosynthesis, Carbon, Chlorophyll a, Irradiation, Nitrogen.

Recent experimental evidence has made it clear that effects of irradiance and nutrient limitation on light absorption and photosynthetic quantum yields of microalgae and the relationship between cellular N:C ratios and nutrient-limited growth rates are inconsistent with the assumptions and predictions of current models of algal growth. A new algal growth model was therefore developed to overcome these inconsistencies. The new model predicts a hyperbolic relationship between nutrient-saturated growth rates and irradiance and a linear relationship between growth rate and both respiration rate and Chl a:C ratios. The correlation between growth rate and Chl a:C is positive under nutrient-limited conditions and negative under nutrient-saturated (light-limited) conditions. The requirement that N:C ratios be linearly related to relative growth rates leads to the conclusion that the product of the Chl a-specific absorption coefficient and the quantum yield coefficient be hyperbolically related to nutrient-limited growth rates, a result consistent with experimental observations. The equations relating respiration rate and compositional ratios to absolute and relative growth rates appear to be insensitive to photoperiod. (See also W91-01139) (Author's abstract) W91-01140

**BACTERIAL MEDIATION IN THE UTILIZATION OF CARBON AND NITROGEN FROM DETRITAL COMPLEXES BY CRASSOSTREA VIRGINICA.**

Maryland Univ., Cambridge. Center for Environmental and Estuarine Studies. M. P. Crosby, R. I. E. Newell, and C. J. Langdon. Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 625-639, May 1990. 8 tab, 76 ref. NSF Grant OCE 84-00020.

Descriptors: \*Bacterial physiology, \*Cycling nutrients, \*Oysters, \*Salt marshes, Carbon radioisotopes, Detritus, Nitrogen radioisotopes.

Unattached, cellulolytic bacteria isolated from a salt marsh were cultured on (15N)ammonium sulfate and (14C)glucose and fed to the American oyster Crassostrea virginica. Oysters were able to digest and assimilate bacterial C with an assimilation efficiency of 52.5%. It is estimated that free-living bacteria may be capable of supplying up to about 9.5% of the total C requirements of oysters in their natural habitat. Cellulolytic bacteria were also cultured on 14C-labeled refractory Spartina alterniflora particles as the sole C source and (15N)ammonium sulfate as a source of N. These labeled bacteria, together with the S. alterniflora, were fed to the oysters. The refractory C from these detrital complexes was assimilated by the oysters with an efficiency of 10.3%. It was significantly (P=0.0007) greater than the assimilation

efficiency of 2.7% measured in a previous study for oysters feeding on the refractory *S. alterniflora* substrate alone. This result provides direct experimental evidence that cellulolytic bacteria in the environment can contribute to the transfer of C from refractory detritus to an ecologically important suspension-feeding macroinvertebrate, *C. virginica*, when fed detrital complexes, assimilated bacterial N with an efficiency of 57.2% but that assimilation of total N present in the detrital complexes was only 3.4%. We speculate that this low assimilation efficiency was due to most (94%) of the N being in the form of condensation products such as humic geopolymers and extracellular polymeric substances secreted by bacteria which could not be digested and absorbed by the oysters. Calculations show that detrital complexes in the natural environment may provide a significant contribution to an oyster's C demand. The magnitude of this contribution can increase from 1.3 to 60% as both absolute bacterial abundance and proportion of bacteria attached to detrital particles increase, raising the oysters' efficiency of filtration for these substrates. (Author's abstract)

W91-01141

#### ROLE OF NUTRITION IN REGULATING THE POPULATION DYNAMICS OF OPPORTUNISTIC, SURFACE DEPOSIT FEEDERS IN A MESOHALINE COMMUNITY.

Maryland Univ., Solomons. Chesapeake Biological Lab.

A. G. Marsh, and K. R. Tenore. *Limnology and Oceanography* LIOCAH, Vol. 35, No. 3, p 710-724, May 1990. 9 fig, 3 tab, 48 ref. NSF Grant No. OCE-85-16-751.

Descriptors: \*Bivalves, \*Brackish water, \*Chesapeake Bay, \*Estuarine environment, \*Limiting nutrients, \*Nutrition, \*Population dynamics, \*Polychaetes.

The role of food resources in regulating seasonal population dynamics was determined in a benthic community typical of mesohaline regions in Chesapeake Bay. Four macroinvertebrates dominated the community: the bivalve *Macoma balthica*, the polychaetes *Streblospio benedicti* and *Nereis succinea*, and the amphipod *Leptocheirus plumulosus*. Several factors seem to regulate population dynamics at different times of the year. In March, growth and reproduction rates accelerated as temperature and phytoplankton sedimentation increased. In April, invertebrate growth rates plateaued while estimated community N requirements were equivalent to estimated N availability. In May, invertebrate growth and reproduction rates rapidly declined while estimated community energy requirements were greater than sediment energy supplies. In June, larval recruitment was heavy for *S. benedicti* and *L. plumulosus*; however, these juveniles showed no apparent growth during June and their densities rapidly declined. The sudden appearance and disappearance of these juveniles was solely responsible for the boom-and-bust dynamics of *S. benedicti* and *L. plumulosus*. Essential W3-polyunsaturated fatty acids and essential amino acids were present at high levels in spring but were present in only trace amounts during summer. Growth of juvenile *S. benedicti* and *L. plumulosus* recruits was most likely limited by food supply in June and July, especially by the availability of essential nutrients. Estimates of predation rates could not account for these population declines. (Author's abstract)

W91-01145

#### MULTIVARIATE STATISTICAL ANALYSES OF SEDIMENT GEOCHEMISTRY.

University of East Anglia, Norwich (England). School of Environmental Sciences.

A. Grant. *Marine Pollution Bulletin* MPNBAZ, Vol. 21, No. 6, p 297-298, June 1990. 2 fig, 3 tab, 5 ref.

Descriptors: \*Geochemistry, \*Marine pollution, \*Marine sediments, \*Mineralogy, \*Pollutant identification, \*Statistical methods, \*Water analysis, \*Water chemistry, Australia, Calcium, Clays, Contaminated sediments, Copper, Heavy metals, Humber Estuary, Lead, Nickel, Silicon.

The effects of sediment mineralogy are often confounded by the effects of concentration differences caused by contamination. Multivariate statistical methods were used to identify locally elevated concentrations of elements in sediments which are usually attributed to man-made contamination, and not to sediment mineralogy. The commonest multivariate method used to identify man-made contamination involves the calculation of intersample similarities and the use of cluster analysis to identify similar groups. This approach is better suited for the identification of gross mineralogical differences than for identifying contamination. An example, copper levels in uncontaminated mud, is shown to be higher than copper levels in contaminated sand where both mud and sand came from the Humber estuary. Forty-five samples from New South Wales subjected to cluster analysis divided into three groups: one, high in clay minerals, represented by high levels of Ni, Cu and Pb; two, high in quartz, represented by high Si levels; and three, high in shell gravel, represented by high Ca levels. From these, and other related, data it is clear that the first group is relatively high in clay minerals, with which Ni, Cu, and Pb are usually associated; the second group represents sediments rich in quartz; while the third group represents sediment containing shell gravel. So, cluster analysis applied in this way does not achieve the desired purpose. An alternative method is principal component analysis (PCA), which determines new additive variables with account for a maximum proportion of the variance. (King-PTT)

W91-01161

#### BIOFILM CHARACTERISTICS IN COASTAL WATERS OF BOMBAY.

Naval Chemical and Metallurgical Lab., Bombay (India).

R. B. Srivastava, S. N. Gaonkar, and A. A. Karande.

*Proceedings of the Indian Academy of Sciences (Animal Sciences)* PIANDR, Vol. 99, No. 2, p 163-173, March 1990. 4 fig, 8 tab, 22 ref.

Descriptors: \*Biofilms, \*Bombay, \*Coastal waters, \*Fouling, \*Heavy metals, Copper, India, Marine pollution, Nickel, Toxicity.

The generation of biofilms on metal and non-metal coupons which were immersed in Bombay coastal waters was studied in the field and in the laboratory. The nature of the biofilm formed varied from substrate to substrate, influenced by the quality of water, flow conditions, and the biotic status of the seawater. The biofilms, depending upon the degree of entrapment of the inorganic detritus, have varying weights. The biofilms formed on metallic surfaces, when compared with perspex surfaces, are both qualitatively and quantitatively richer. Cupronickel, despite its toxicity, supports denser films than those which developed on inert perspex surfaces. The metallic coupons, both inert and toxic, support thicker films in polluted waters than in clean waters. (Author's abstract)

W91-01170

#### PRODUCTION AND CARBON ISOTOPIC COMPOSITION OF BACTERIAL CO<sub>2</sub> IN DEEP COASTAL PLAIN SEDIMENTS OF SOUTH CAROLINA.

Geological Survey, Columbia, SC. Water Resources Div.

For primary bibliographic entry see Field 2J. W91-01297

#### ENVIRONMENTAL IMPACT OF NORTH SEA OIL.

Dundee Univ. (Scotland). Dept. of Biological Sciences.

For primary bibliographic entry see Field 5C. W91-01329

#### NITROGEN CYCLING IN LOUISIANA GULF COAST BRACKISH MARSHES.

Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.

R. D. DeLaune, and W. H. Patrick. *Hydrobiologia* HYDRB8, Vol. 199, No. 1, p 73-79,

July 17, 1990. 5 fig, 1 tab, 21 ref. NSF grant BSR-8413006.

Descriptors: \*Brackish water, \*Louisiana, \*Nitrogen, \*Nitrogen cycle, \*Nitrogen fixation, \*Salt marshes, \*Wetlands, Ammonium, Nitrogen budget, Seasonal variation, Sediments, Soil profiles, Spartina.

Nitrogen fixation and nitrogen accumulation were measured in a Louisiana *Spartina patens* brackish marsh. Using the acetylene reduction technique calibrated with direct <sup>15</sup>N<sub>2</sub> assimilation, an equivalent of 90.0 microg N/g/yr was fixed. Fixation was greater in the summer months and in the upper portion of the soil profile. Extractable ammonium increased with depth and was negatively correlated with ethylene production. Average ammonium concentration in the sediment was 39 microg NH<sub>4</sub>(+) as N/g sediment. Cesium-137 dating of the soil profile showed the marsh was vertically accreting at a rate of 0.60 cm/yr. Calculations using vertical accretion rate, bulk density, and total nitrogen content of sediment indicated that the marshes are accumulating 7.2g N/sq m/yr, thus serving as a major nitrogen sink. By incorporating measured nitrogen fluxes with existing flux measurement a nitrogen budget was developed for the marsh. The data suggest that nitrogen fixation is the primary source of nitrogen in this marsh. These results are in contrast to the salt marshes nearer the coast where sediment input was definitely the primary source of nitrogen. (Author's abstract)

W91-01351

#### TEMPERATURE SELECTION BY STRIPED BASS IN A GULF OF MEXICO COASTAL RIVER SYSTEM.

Georgia Cooperative Wildlife Research Unit, Athens.

For primary bibliographic entry see Field 8I. W91-01385

#### MATHEMATICAL MODEL OF BACTERIAL CONTAMINATION OF THE MORLAIX ESTUARY (FRANCE).

IFREMER, Paris (France).

For primary bibliographic entry see Field 5B. W91-01419

#### PROPERTIES OF UNSTABLE WAVES IN THE LOWER ST. LAWRENCE ESTUARY.

Quebec Univ., Rimouski. Dept. of Oceanography.

G. Mertz, Y. Gratton, and J. A. Gagne. *Atmosphere - Ocean ATOCDA*, Vol. 28, No. 2, p 230-240, June 1990. 5 fig, 18 ref.

Descriptors: \*Eddies, \*Estuaries, \*Fluid dynamics, \*Oscillatory waves, \*St Lawrence Estuary, \*Waves, Canada, Mathematical analysis, Mathematical models, Mathematical studies, Model studies, Wave direction, Wave velocity.

The lower St. Lawrence estuary is an interesting case among estuaries in that it is wide enough to accommodate the development of mesoscale unstable waves and eddies. These features are generated by the runoff-driven jet along this body's south shore. Data are presented yielding estimates of the length, time and velocity scales of these unstable disturbances. To relate these quantities to the dynamics employed, a 2-layer quasigeostrophic instability model featuring realistic lateral shear. All model runs show short time and length scales, e-folding periods of less than 10 days and wavelengths of less than 50 km. The lower St. Lawrence estuary is an unusual domain for mesoscale unstable waves since it is semi-enclosed. The northern lateral boundary prevents eddies that are shed from the south-shore jet from migrating far offshore. This may imply re-interaction of the eddy with the south-shore jet, perhaps yielding a merging event or alternatively a new cycle of wave growth. (Author's abstract)

W91-01431

#### TIDAL DYNAMICS OF THE WATER TABLE IN BEACHES.

## Field 2—WATER CYCLE

### Group 2L—Estuaries

Sydney Univ. (Australia). Ocean Technology Group.  
For primary bibliographic entry see Field 2F.  
W91-01528

**LATERAL DISTRIBUTION OF SUSPENDED SEDIMENTS IN NEARSHORE WATER OF MUDDY COAST OF LIANYUNGANG HARBOR (IN CHINESE).**  
East China Normal Univ., Shanghai. Inst. of Estuarine and Coastal Research.  
For primary bibliographic entry see Field 2J.  
W91-01567

**CLASSIFICATION OF ESTUARIES IN CHINA (IN CHINESE).**  
East China Normal Univ., Shanghai.  
Y. H. Jin, H. T. Shen, and J. Y. Chen.  
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 2, p 132-143, March 1990. 5 fig, 6 tab, 8 ref. English summary.

Descriptors: \*China, \*Estuaries, Changjiang River, Classification, Cluster analysis, Data interpretation, Huang He River, Qiantang River, River sediments, Sheyang River, Stream classification, Yangtze River, Yellow River, Zhujiang River.

The estuaries of China were classified into four basic types, by using data from 27 large rivers which were analyzed using fuzzy cluster analysis for those factors which influence the deformation, erosion-accumulation and evolution of an estuary. The comprehensive classification principle treats an estuary as a complex physiographic system including estuarine hydraulic behavior, sediment concentration and source and plane features. The four estuary types determined using this method are: 1) Qiantang River Estuary type, funnel-shaped, laterally inhomogeneous, sediment from the sea; 2) Transitional estuary type, subdivision one, Sheyang River Estuary type, meander type, partially mixed, sediment primarily from the sea; subdivision two, Changjiang River (Yangtze River) Estuary type, branched type, partially mixed, sediment from both sea and land; 3) Zhujiang River Estuary type, network type, partially mixed, sediment primarily from the land; and 4) Huanghe River (Yellow River), wandering type, highly stratified, sediment from the land. The different classifications of estuaries are described in terms of the ratio of mean flood tidal discharge to the mean river discharge into the sea (QR), and the ratio of the rate of the mean flood tidal sediment transportation to the rate of the mean river sediment transportation (SR). The tidal range and plane feature of an estuary are the primary classification indexes when QR and SR are unknown. The classification system has been satisfactorily applied to foreign rivers. (Author's abstract)  
W91-01570

**EXISTING FORMS OF PHOSPHORUS IN SEDIMENT FROM MIDDLE AND NORTHERN TAIWAN STRAIT (IN CHINESE).**  
Fujian Inst. of Oceanology, Xiamen (China).  
J. S. Xu, and L. G. Li.  
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 1, p 62-69, January 1990. 9 fig, 8 ref. English summary.

Descriptors: \*Cycling nutrients, \*Marine sediments, \*Phosphorus, \*Sediment chemistry, \*Taiwan, Aluminum, Copper, Hydrogen ion concentration, Indicators, Iron, Organic carbon, Taiwan Straits, Water quality, Zinc.

The distribution of phosphorus species and their concentrations in sediments from middle and northern parts of Taiwan Strait are presented. In the area surveyed, the concentration of phosphorus bound up in calcium-based matrices (Pca) makes up 90% of the total content of inorganic phosphorus (Pinorg). The level of Pca concentration is closely related to hydrodynamics, sea water temperature, and pH values, as well as others. The level of phosphorus in aluminum-based matrices (Pal) and the level of phosphorus in iron-based matrices (Pfe) is positively correlated with the levels of organic carbon, copper, and zinc. Pal and

Pfe could also be used as an indicator of pollution in the marine environment. The level of soluble phosphorus is correlated with environmental oxidation-reduction, and it increases in reductive condition. (Author's abstract)  
W91-01575

**TWO-DIMENSIONAL NUMERICAL CALCULATION OF RESIDUAL CURRENT AND SALINITY AT THE CHANGJIANG RIVER ESTUARY (IN CHINESE).**  
Academia Sinica, Qingdao (China). Inst. of Oceanology.  
K. J. Yu.  
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 1, p 92-112, January 1990. 6 fig, 5 ref, 4 plates. English summary.

Descriptors: \*China, \*Estuaries, \*Mathematical models, \*Salinity, \*Yangtze River, Changjiang River, Model studies, Water currents, Wind-driven currents.

The distribution of residual current and salinity in the Changjiang River (Yangtze River) estuary were compared for summer and winter by using a finite-difference method based on two-dimensional nonlinear equations of motion and salinity diffusion equations. The results show that the residual currents flow northeastward because of the influence of south winds in summer, but, in winter, they flow southwestward or southeastward because of the influence of the north wind. The salinity distribution corresponds to that of the residual currents. The salt tongue tends to be northeastward in summer, but southeastward in winter. The distributions of equal-salinity lines outside of the Changjiang River estuary were usually westward as a result of less discharge during the winter season. The analyses of residual currents and salinity were used to predict the possible effects of the Three Gorges project. (Author's abstract)  
W91-01578

**MICROORGANISMS IN MARINE SEDIMENTS: CONSIDERATIONS CONCERNING ACTIVITY MEASUREMENTS.**  
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.  
For primary bibliographic entry see Field 2J.  
W91-01585

**GROWTH OF BACTERIA ON ORGANIC MATTER PRODUCED BY ALGAE IN CONTINUOUS CULTURES.**  
Ceskoslovenska Akademie Ved, Prague. Hydrobiologicka Lab.  
For primary bibliographic entry see Field 2H.  
W91-01589

**ALGAL EXUDATION AND ITS RELATION TO BACTERIAL PRODUCTION DURING VERNAL PHYTOPLANKTON BLOOMS.**  
Tvarminne Zoological Station (Finland).  
For primary bibliographic entry see Field 2H.  
W91-01592

**DELAYED DEVELOPMENT OF BACTERIOPLANKTON WITH RESPECT TO PHYTOPLANKTON: A CLUE FOR UNDERSTANDING THEIR TROPIC RELATIONSHIPS.**  
Universite Libre de Bruxelles (Belgium). Groupe de Microbiologie des Milieux Aquatiques.  
G. Billen.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 191-201, 1990. 7 fig, 33 ref. Services de Programmation de la Politique Scientifique (Brussels) Contract ARC, ANTARO5 and EEC Contract ENV-522-B.

Descriptors: \*Bacterioplankton, \*Marine environment, \*Mathematical models, \*Model studies, \*Phytoplankton, \*Population dynamics, Algal blooms, Antarctica, Aquatic bacteria, Bacterial physiology, Dissolved solids, Growth rates, Marine bacteria, North Sea, Nutrients, Organic matter, Simulation analysis, Substrates.

Bacterioplankton development is mainly dependent on the release of dissolved organic matter by phytoplankton and is expected in aquatic systems receiving major inputs of allochthonous organic matter. A distinct delay is observed in the response of bacteria to phytoplankton development, both during spring bloom in temperate marine systems and during the summer months in the Antarctic ecosystem (about 10 d in the North Sea, about 1 mo in Antarctica). Use of mathematical simulation of bacterial dynamics showed that such delays cannot be explained if phytoplankton exudation of low molecular weight substrates was the dominant process supplying dissolved organic matter to bacteria. Instead, these delays are correctly simulated assuming that the major source of organic substrates used for bacterial growth consists in the release of macromolecular compounds by post mortem lysis of algal cells. (Author's abstract)  
W91-01609

**DYNAMICS OF PELAGIC CILIATES IN EUTROPHIC ESTUARINE WATERS: IMPORTANCE OF FUNCTIONAL GROUPS AMONG CILIATES AND RESPONSES TO BACTERIAL AND PHYTOPLANKTON PRODUCTION.**  
Akademie der Wissenschaften der DDR, Berlin. Inst. fuer Geographic und Geoökologie.  
H. Arndt, G. Jost, and N. Wasmund.  
Ergebnisse der Limnologie ERLIA6, Vol. 34, p 239-245, 1990. 3 fig, 19 ref.

Descriptors: \*Aquatic productivity, \*Bacterial productivity, \*Ecosystems, \*Estuaries, \*Eutrophication, \*Food habits, \*Phytoplankton, \*Population dynamics, \*Protozoa, Algal blooms, Aquatic bacteria, Baltic Sea, Dars-Zingst Estuary, Food chains, Mineralization, Nutrient transport, Seasonal variation, Species composition.

The planktonic ciliate community was investigated during field studies and enclosure experiments in the shallow eutrophic Dars-Zingst estuary (southern Baltic). The functional groups of ciliates were separated according to their main food items known from literature and from observations. In response to temporal changes in the production of bacteria and phytoplankton, changes in the composition of the ciliate community appeared. Algae dominated during the spring bloom and in early summer and early autumn, corresponding to the pulses of small phytoflagellates and green algae, respectively. Bacterivorous ciliates were of the highest importance during summer and autumn. Estimates of the feeding rates of functional groups revealed no significant impact of algae but bacterivores should be able to consume one third of annual bacterial production and can control bacterial production during certain periods. At high concentrations of ciliates, their density seemed to be regulated within the pelagic ciliate community itself by the impact of omnivores. Nutrient loading into enclosures during summer did not lead to considerable changes in ciliate community. The most important function of pelagic ciliates within the matter flux of this estuarine community seems to be the mineralization of bacterial production. (Author's abstract)  
W91-01613

**RESPONSE OF COASTAL ZONE MANAGEMENT PROGRAMS TO SEA LEVEL RISE IN THE UNITED STATES.**  
Washington Univ., Seattle. Inst. for Marine Studies.  
For primary bibliographic entry see Field 6B.  
W91-01619

**EYE TO EYE WITH HURRICANE GLORIA ON VIRGINIA'S TANGIER ISLAND.**  
Old Dominion Univ., Norfolk, VA.  
For primary bibliographic entry see Field 6B.  
W91-01620

**PERMIT REFORM THROUGH COASTAL CONSISTENCY PREVIEW: AN ANALYSIS OF ALASKA'S COORDINATED PROCESS.**  
Alaska Univ., Fairbanks.

For primary bibliographic entry see Field 6F.  
W91-01621

**TRIBUTYL TIN AND INVERTEBRATES OF A SEAGRASS ECOSYSTEM: EXPOSURE AND RESPONSE OF DIFFERENT SPECIES.**

Cornell Univ., Ithaca, NY. Ecosystems Research Center.  
For primary bibliographic entry see Field 5C.  
W91-01625

**ENVIRONMENTAL FACTORS AFFECTING BENTHIC INFAUNAL COMMUNITIES OF THE WESTERN ARABIAN GULF.**

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Research Inst.  
S. L. Coles, and J. C. McCain.  
Marine Environmental Research MERSDW, Vol. 29, No. 4, p 289-315, 1990. 4 fig, 9 tab, 39 ref.

Descriptors: \*Benthic environment, \*Benthic fauna, \*Coastal environment, \*Coasts, \*Species diversity, \*Water pollution effects, Fate of pollutants, Hydrocarbons, Persian Gulf, Petroleum products, Population density, Salinity, Sea grasses, Sediments.

Species composition and abundances of benthic organisms >0.5 mm in size were determined in seagrass and sand/silt substrata along the Saudi Arabian Gulf coastline. Synoptic measurements were made of environmental and pollution-related parameters. Numbers of species and individuals were significantly greater in seagrass than in sand/silt substrata, indicating that the finer grained sediments of the seagrass areas support more diverse and abundant benthic communities. In both seagrass and sand/silt, abundances of species and individuals decrease significantly with increasing salinity, resulting in substantially reduced benthic communities in the Gulf of Salwah at the southern extent of the western Gulf where salinities average up to 56.5 ppt. In contrast, biomass of the total benthos in the sand/silt substratum increases significantly with salinity. All pollution-related parameters tested indicated relatively low concentrations in sediments. The only significant relationship found with the benthos was an increase in numbers of individuals with sediment petroleum hydrocarbons, resulting in significantly lower species diversities in areas of higher sediment petroleum. The most abundant organism in the area increases significantly with sediment petroleum hydrocarbons within the relatively low concentrations that do occur, indicating that this species is primarily responsible for the observed relationship between petroleum hydrocarbons, numbers of individuals and species diversity. (Author's abstract)  
W91-01626

**CONTRIBUTION OF BENTHIC BIOMASS TO OVERALL METABOLISM IN NEW CALEDONIA LAGOON SEDIMENTS.**

Musee National d'Histoire Naturelle, Paris (France). Biologie des Invertebres Marins.  
G. Boucher, and J. Clavier.  
Marine Ecology Progress Series MESEDIT, Vol. 64, No. 3, p 271-280, July 12, 1990. 5 fig, 4 tab, 63 ref.

Descriptors: \*Benthic environment, \*Benthic fauna, \*Benthic flora, \*Benthos, \*Dissolved oxygen, \*Dissolved solids, \*Lagoons, \*New Caledonia, \*Nitrogen, \*Sediment-water interfaces, Bottom sampling, Bottom sediments, Mud, Regression analysis, Sand, Sediment analysis.

Granulometric parameters, benthic biomasses of living organic matter, and oxygen and nitrogen fluxes at the water-sediment interface were investigated on triplicate samples, or in dark experiments, at 12 stations in the lagoon in SW New Caledonia. Analysis of functional characteristics of 3 bottom types revealed significant differences in the benthic food-webs. Onshore muddy bottoms had the lowest respiration, related to the lowest adenotriphosphate (ATP) pool and meiofauna density, in spite of high organic and pigment content. Near-reef white-sand bottoms were a sink for dissolved organic nitrogen (DON), exported no significant

dissolved inorganic nitrogen (DIN), and supported the highest living biomass (ATP) via meiofauna and active microphytes. Intermediate grey-sand bottoms had the highest respiration, related to macrophyte cover and to a lesser extent to larger macrobenthos biomass, and were a source of nutrients for the water-column (DIN and DON). Partitioning of benthic biomass was investigated using non-linear multiple regression. Oxygen consumption was mainly related to ATP content, considered as representative of microfauna and meiofauna biomass, then to macrophyte biomass and to a lesser extent to macrofauna biomass. Pigment content did not improve the relationship. Depletion of inorganic nitrogen efflux, when compared to high respiration rates, increased from muddy bottoms to white-sand bottoms. Organic nitrogen (DON) exchanges were an order of magnitude greater than DIN exchanges indicating a considerable nitrogen demand in the sediment. (Author's abstract)  
W91-01659

**EFFECTS OF SUNLIGHT AND AUTOCHTHONOUS MICROBIOTA ON ESCHERICHIA COLI SURVIVAL IN AN ESTUARINE ENVIRONMENT.**

Virginia Inst. of Marine Science, Gloucester Point. Dept. of Biological and Fisheries Sciences.  
For primary bibliographic entry see Field 5B.  
W91-01663

**USE OF THE MUSSEL WATCH AND MOLECULAR MARKER CONCEPTS IN STUDIES OF HYDROCARBONS IN A TROPICAL BAY (TODOS OS SANTOS, BAHIA, BRAZIL).**

Centro de Investigacion y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry.  
For primary bibliographic entry see Field 5A.  
W91-01690

**RIVER DISCHARGE AND TIDAL CONTROLS ON SALT-WEDGE POSITION AND IMPLICATIONS FOR CHANNEL SHOALING: FRASER RIVER, BRITISH COLUMBIA.**

Guelph Univ. (Ontario). Dept. of Geography.  
R. A. Kostaschuk, and L. A. Atwood.  
Canadian Journal of Civil Engineering CICEB8, Vol. 17, No. 3, p 452-459, June 1990. 7 fig, 22 ref.

Descriptors: \*British Columbia, \*Channels, \*Estuaries, \*Rivers, \*Sedimentation, \*Shoals, \*Tidal effects, \*Tidal hydraulics, Regression models, Saline water intrusion, Statistical analysis.

Salinity and current surveys in the Main Channel of the Fraser River estuary, British Columbia, show that a well-defined salt-wedge intrusion migrates along the channel. Bivariate statistical analyses reveal that when discharge is nearly constant, the position of the salt-wedge is controlled by tidal height. Multivariate analyses of data with large ranges in discharge and tidal height indicate that intrusion location is a function of both discharge and tides. Multiple regression models were derived to predict salt-wedge position from river discharge and tidal height, for combined high and low tides, and for high tides and low tides separately. The high-tide model is the most precise, followed by the combined and then the low-tide models. The lower precision for the combined and low-tide models is probably due to the difficulty in accurately locating the salt-wedge tip at low tide. An analysis of channel bathymetric surveys and dredging records and application of the low-tide regression model reveals that the low-tide position of the salt-wedge is responsible for channel shoaling near the river mouth at Sand Heads. Shoaling produces a navigation hazard and is linked to submarine slope failures. (Author's abstract)  
W91-01722

**POLYCHLORINATED DIBENZOFURAN (PCDF) AND DIBENZO-P-DIOXIN (PCDD) LEVELS IN ORGANISMS AND SEDIMENTS FROM THE FRIERFJORD, SOUTHERN NORWAY.**

Norsk Inst. for Vannforskning, Oslo.  
For primary bibliographic entry see Field 5B.

W91-01726

**PERSISTENT METABOLITES OF ALKYL-PHENOL POLYETHOXYLATES IN THE MARINE ENVIRONMENT.**

Venice Univ. (Italy). Dept. of Environmental Science.  
For primary bibliographic entry see Field 5B.  
W91-01754

**TRENDS IN THE HEAVY METAL LEVELS IN THE DISSOLVED AND PARTICULATE PHASE IN THE DUTCH RHINE-MEUSE (MAAS) DELTA.**

Warsaw Univ. (Poland). Dept. of Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-01817

**SPATIAL AND SEASONAL DIFFERENCES IN THE PCB CONTENT OF THE MUSSEL MYTILUS EDULIS.**

Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).  
For primary bibliographic entry see Field 5B.  
W91-01819

**HYDROGRAPHIC SURVEYS AND SEDIMENTATION IN DEEP BAY, HONG KONG.**

Hong Kong Polytechnic, Kowloon. Dept. of Civil and Structural Engineering.  
For primary bibliographic entry see Field 2J.  
W91-01883

**NUTRIENT EXCHANGES BETWEEN THE WATER COLUMN AND A SUBTIDAL BENTHIC MICROALGAL COMMUNITY.**

Virginia Inst. of Marine Science, Gloucester Point.  
For primary bibliographic entry see Field 2H.  
W91-01897

**INTERPRETATION OF METAL CONCENTRATIONS IN ESTUARINE SEDIMENTS OF FLORIDA USING ALUMINUM AS A REFERENCE ELEMENT.**

Florida State Dept. of Environmental Regulation, Tallahassee.  
S. J. Schropp, F. G. Lewis, H. L. Windom, J. D. Ryan, and F. D. Calder.  
Estuaries ESTUDO, Vol. 13, No. 3, p 227-235, September 1990. 6 fig, 1 tab, 27 ref.

Descriptors: \*Aluminum, \*Biscayne Bay, \*Data interpretation, \*Estuarine sediments, \*Florida, \*Metals, \*Path of pollutants, Estuaries, Miami River, Sediment contamination.

Metal contamination of estuarine sediments is an increasing problem in Florida, and elsewhere, as urbanization extends into previously undeveloped areas. Effective estuarine management practices require scientifically valid tools to assess the extent of estuarine contamination. Interpretation of anthropogenic metal contributions has been hampered by the fact that natural metal concentrations in sediments vary by orders of magnitude in different sediments. Normalization of metal concentrations to a reference element, aluminum, appears to be a promising method for comparing estuarine sediment metal concentrations on a regional basis. The description is presented of an interpretive method based on the relationship between sediment metals and aluminum, derived from statewide data on natural estuarine sediments in Florida. Examples from the Miami River and Biscayne Bay show how this method can be used to interpret metal concentrations. This interpretive tool provides a simple method for evaluating sediment metal data and allows results of sediment chemical analyses to be used for a variety of environmental information needs including: (1) distinguishing natural versus enriched metal concentrations in estuarine sediments; (2) comparing metal concentrations within an estuary; (3) comparing results from different estuaries; (4) tracking the spatial influence of a known pollution source; (5) monitoring temporal trends in metal concentrations; (6) examining data

## Field 2—WATER CYCLE

### Group 2L—Estuaries

for procedural or laboratory errors; and (7) as a screening tool to promote the cost-effective use of other tests (e.g., bioassay, elutriate). (Lantz-PTT) W91-01898

#### MODELING OF WIND-INDUCED DESTRATIFICATION IN CHESAPEAKE BAY.

HydroQual, Inc., Mahwah, NJ.  
A. F. Blumberg, and D. M. Goodrich.  
Estuaries ESTUDO, Vol. 13, No. 3, p. 236-249, September 1990. 12 fig, 5 tab, 31 ref. EPA Contract No. 68-03-3319.

Descriptors: \*Chesapeake Bay, \*Destratification, \*Estuaries, \*Mixing, \*Model studies, \*Wind-driven currents, Bays, Oxygen, Salinity, Tides, Turbulence, Vertical distribution.

It has been observed that storms in early fall can result in top to bottom mixing of the Chesapeake Bay. A three-dimensional, time dependent circulation model was used to examine this destratification process for September 1983, for which extensive current and hydrographic data are available. The model bay is forced at the surface by observed hourly winds, at the ocean boundary by observed hourly surface and bottom salinities and sea level fluctuations, and at the head by observed daily discharges for a 28-d period. A second-moment, turbulence-closure submodel, with no adjustments from previous applications to its requisite coefficients, was used to calculate the vertical turbulence mixing coefficients. Comparisons with data inside the model domain indicate relative errors of 7% to 14% for sea level, 7% to 35% for current, and 11% to 21% for salinity. The tidal portion of the spectrum is modeled better than the subtidal portion. The model is used to examine both the mechanisms of wind mixing and the temporal and spatial distribution of vertical mixing within the estuary. Wind-driven internal shear is shown to be a more effective mechanism of inducing destratification than turbulence generated at the surface. The model is also used to show that the vertical temperature inversion which occurs in the fall does not effect the timing of the destratification as much as its completeness. The distribution of mid-depth vertical mixing shows highly variable values in the mid-bay region, where wind induced mixing is dominant. This suggests that the source of oxygen to mid-bay bottom waters is similarly variable. Vertical turbulence mixing coefficients of .001 sq cm/s (background) to 1000 sq cm/s were needed to simulate the September period, indicating the need for time-variable mixing in models of dissolved and suspended estuarine constituents. (Author's abstract) W91-01899

#### SHOT-SENSOR METHOD OF MEASURING CURRENTS IN SHALLOW ESTUARINE WATERS.

New Hampshire Univ., Durham. Jackson Estuarine Lab.  
For primary bibliographic entry see Field 7B.  
W91-01900

#### BAROTROPIC, SUBTIDAL EXCHANGE BETWEEN CALCASIEU LAKE AND THE GULF OF MEXICO.

Louisiana State Univ., Baton Rouge. Dept. of Marine Science.  
For primary bibliographic entry see Field 2H.  
W91-01901

#### SALINITY TRENDS IN LOUISIANA ESTUARIES.

Louisiana State Univ., Baton Rouge. Coastal Studies Inst.  
W. J. Wiseman, E. M. Swenson, and J. Power.  
Estuaries ESTUDO, Vol. 13, No. 3, p. 265-271, September 1990. 5 fig, 3 tab, 13 ref. US Minerals Management Service Contract No. 14-12-0001-3052.

Descriptors: \*Estuaries, \*Louisiana, \*Salinity, Analysis of variance, Bayou Lafourche, Mississippi River, Statistical analysis, Time series analysis.

Nonparametric tests for the presence of a trend in the time series of various salinity statistics were performed. Analysis of existing salinity time series from coastal Louisiana show that statistically significant trends in mean salinity, salinity variance, and maximum salinity exist. These trends are of both signs, with no apparent large scale spatial pattern. Within individual estuaries, important trends have been identified; for example, increasing salinities within Bayou Lafourche. Linear estimates of the trend magnitudes suggest that the resultant changes in mean salinity, salinity variance, and maximum salinity have generally been small. The magnitudes of the predicted changes in mean salinity are generally small enough to be nondetrimental to the adjacent marsh lands. In a few locations, trends in the salinity regime are large and major changes in marsh vegetation have been observed. Natural variability in these systems, principally due to Mississippi River runoff and local climatology, are high and may hide weak trends. Nevertheless, extensive coastal degradation and land loss have been documented over time periods of the same order as the data records. If this were caused by a trend in the salinity regime, the present analysis should have identified the trend. (Lantz-PTT) W91-01902

#### RELATIONSHIPS BETWEEN WETLAND FRAGMENTATION AND RECENT HYDROLOGIC CHANGES IN A DELTAIC COAST.

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.  
R. E. Turner, and Y. S. Rao.  
Estuaries ESTUDO, Vol. 13, No. 3, p. 272-281, September 1990. 8 fig, 15 ref.

Descriptors: \*Canals, \*Hydrological regime, \*Spoil banks, \*Wetlands, Erosion, Estuaries, Gulf of Mexico, Ponds, Sediment transport.

Patterns in coastal wetland loss in the northern Gulf of Mexico were examined using aerial imagery from 1955-56 and 1978. Five qualitative types of wetland changes are evident: (1) spoil-bank parallel pond formation, (2) pond formation with apparent random distribution for the smallest ponds, but very clumped distribution for larger ponds, (3) semi-, or complete impoundments resulting in open water formation, (4) cutting off of stream channels upstream of where a spoil bank crosses a natural channel, and (5) erosion at the land water interface. Only ponds < 20 ha formed and disappeared in the interval, and it is clear that wetland breakup, not erosion at the pond-lake edge, is the dominant form of wetland to open water conversion. Canals and their spoil banks are spatially related to wetland-to-water conversion which is evident up to 2 km away from those man-made features. The indirect impacts of canals and spoil banks vary regionally, for example, with sediment compaction rates that increase with increasing sediment deposition. These results are consistent with the hypothesis that canals and spoil banks are a major factor driving wetland loss rates because they change wetland hydrology. (Author's abstract) W91-01903

#### COMPARISON OF PHYTOPLANKTON ASSEMBLAGES AND ENVIRONMENTAL RELATIONSHIPS IN THREE ESTUARINE RIVERS OF THE LOWER CHESAPEAKE BAY.

Old Dominion Univ., Norfolk, VA. Dept. of Biological Sciences.  
H. G. Marshall, and R. W. Alden.  
Estuaries ESTUDO, Vol. 13, No. 3, p. 287-300, September 1990. 13 fig, 4 tab, 31 ref.

Descriptors: \*Estuarine environment, \*James River, \*Phytoplankton, Algal blooms, Chesapeake Bay, Nitrogen, Phosphorus, Population dynamics, Rappahannock River, Seasonal variation, York River.

A 16-month data set of phytoplankton assemblages and environmental parameters were studied in the lower James, York (Pamunkey), and Rappahannock rivers using several exploratory statistical approaches. Based on species composition and river station relationships, three site groups were established and subsequently identified as predomi-

nantly tidal fresh, oligo-mesohaline, and mesohaline sites. Phytoplankton assemblages within these rivers were influenced and subsequently augmented by the onset of the spring freshet which was different in 1986 and 1987. Five temporal assemblages of phytoplankters were also identified and designed into seasonal groupings of spring 1986, summer-fall, summer-winter, fall-winter, and winter-spring 1987. Discriminant analysis (MANOVA) evaluations were made for water quality parameters to site and seasonal phytoplankton assemblages. Moving downstream along the oligohaline-mesohaline gradient, the nitrogen and phosphorous levels decreased and the phytoplankton composition was more similar at several corresponding site locations in the different rivers than at stations relatively close to each other in the same river. Within these data sets, approximately 58% of the explained variance was associated with site (spatial) effects, 30% with temporal effects, and 12% with site-temporal interactions. A transition from dominant bloom-producing freshwater diatoms to estuarine species occurs from the tidally influenced freshwater zone downstream. This change may be rapid as the decline of *Skeletonema potamos*, or gradual, as with *Cyclotella striata* and *Cyclotella meneghiniana*. These are replaced downstream by *Skeletonema costatum*, *Cyclotella caspis*, and *Leptocylindrus minimus* as dominant species. (Author's abstract) W91-01905

#### EFFECTS OF TRIBUTYL TIN WITHIN A THALASSIA SEAGRASS ECOSYSTEM.

Cornell Univ., Ithaca, NY. Ecosystems Research Center.  
For primary bibliographic entry see Field 5C.  
W91-01906

#### GROWTH OF SUBMERGED MACROPHYTES UNDER EXPERIMENTAL SALINITY AND LIGHT CONDITIONS.

University of Southwestern Louisiana, Lafayette. Dept. of Biology.  
For primary bibliographic entry see Field 2H.  
W91-01907

#### RECRUITMENT FAILURE OF THE BAY SCALLOP, ARGOPECTEN IRRADIANS CONCENTRICUS, DURING THE FIRST RED TIDE, PITYCHODISCUS BREVIS, OUTBREAK RECORDED IN NORTH CAROLINA.

North Carolina Univ., Morehead City. Inst. of Marine Sciences.  
For primary bibliographic entry see Field 5C.  
W91-01908

#### COMPARISON OF THE DIETS OF GULF KILLIFISH, FUNDULUS GRANDIS BAIRD AND GIRARD, ENTERING AND LEAVING A MISSISSIPPI BRACKISH MARSH.

Louisiana Universities Marine Consortium, Chauvin.  
L. P. Rozas, and M. W. LaSalle.  
Estuaries ESTUDO, Vol. 13, No. 3, p. 332-336, September 1990. 1 fig, 3 tab, 27 ref.

Descriptors: \*Biological studies, \*Fish diets, \*Killifish, \*Marshes, \*Tidal marshes, Amphipods, Comparison studies, Crabs, Ecosystems, Estuaries, Estuarine environment, Fish food, Polychaetes, Tides.

An examination was conducted of the diets of Gulf Killifish, *Fundulus grandis* Baird and Girard, collected monthly from March through July 1988 with unbaited minnow traps during two sampling periods: (1) on flood tides before they reached the marsh surface, and (2) on ebb tides as they left the marsh. Thirty-five prey taxa, plant parts, and detritus were identified from the stomach contents of 110 Gulf Killifish (mean SL = 55 mm, range = 30-82 mm). Fiddler crabs, *Uca longisignalis* Salmon and Atsides; amphipods, mostly *Corophium louisianum* Shoemaker; tanaidaceans, *Hargeria rapax* (Harger); and hydrobiids, *Littoridinops palustris* Thompson, were their most important prey. Killifish diets differed both quantitatively

and qualitatively relative to the habitat in which they were feeding. Fiddler crabs and polychaetes were consumed more frequently and in greater numbers in the intertidal zone, whereas more amphipods were eaten by killifish feeding in subtidal and low intertidal areas. Gulf Killifish consumed greater volume of food when they had access to the marsh surface than when they were confined to subtidal areas. (Author's abstract)  
W91-01909

#### EFFECT OF TIDAL FLOODING ON MORTALITY OF JUVENILE MUSKRATS.

Louisiana State Univ., Baton Rouge. School of Forestry and Wildlife Management.  
Q. J. Kinler, R. H. Chabreck, N. W. Kinler, and R. G. Linscombe.  
Estuaries ESTUDO, Vol. 13, No. 3, p 337-340, September 1990. 2 fig, 26 ref.

Descriptors: \*Brackish water, \*Ecological effects, \*Marshes, \*Mortality, \*Muskrats, \*Tidal floods, Population dynamics, Sea level, Seasonal variation, Water level.

An investigation was conducted in the brackish marsh in Louisiana by examining 50 muskrat lodges each month from July 1984 to June 1985 and tidal data over a 19 year period. Tide levels increased at a rate of 1.58 cm/yr during the 19-yr period prior to the study, and during the study, nest chambers in muskrat lodges were flooded on 43 d. Seventy-seven captured litters averaged 2.2  $\pm$  0.3 young per litter. Older litters were less common than younger litters, but the number of young per litter did not differ among 5-d age classes, suggesting that mortality factors usually affected entire litters. The frequency of tidal flooding prior to the opening of lodges each month was associated negatively with the number of litters and number of young per litter. If marsh subsidence and sea level rise continue, tidal flooding will become more prevalent and litter mortality will likely increase. (Author's abstract)  
W91-01910

#### FOOD HABITS OF TWO LARVAL FLIES (DOLICHOPODIDAE: DIPTERA) IN TWO GULF COAST OLIGOHALINE TIDAL MARSHES.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.  
M. W. LaSalle, and T. D. Bishop.  
Estuaries ESTUDO, Vol. 13, No. 3, p 341-348, September 1990. 2 fig, 3 tab, 42 ref.

Descriptors: \*Ecosystems, \*Flies, \*Food habits, \*Tidal marshes, \*Wetlands, Energy, Estuarine environment, Food chains, Marshes, Nematodes, Oligochaetes, Polychaetes.

Food habits were analyzed from two species of dolichopodid fly larvae through monthly collections taken between June 1979 and May 1980. Larvae of *Pelastonerus abbreviatus* Loew and *Thinophilus frontalis* Van Duzee, taken from a *Juncus roemerianus* Scheele dominated marsh, fed predominantly on oligochaetes and nematodes. *Pelastonerus abbreviatus*, collected in a nearby *Spartina cynosuroides* (L.) Roth marsh, also fed on oligochaetes but consumed more polychaetes than nematodes. By being predators and prey in turn, these larvae serve in the transfer of energy between benthic, aquatic, and terrestrial components of the marsh system. (Author's abstract)  
W91-01911

#### PHOSPHATE LIMITATION IN ESTUARINE AND COASTAL WATERS OF CHINA.

British Columbia Univ., Vancouver. Dept. of Botany.  
P. J. Harrison, M. H. Hu, Y. P. Yang, and X. Lu.  
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 140, No. 1/2, p 79-87, July 31, 1990. 4 fig, 38 ref.

Descriptors: \*China, \*Limiting nutrients, \*Nitrates, \*Phosphorus, \*Phytoplankton, \*Primary productivity, Coastal areas.

Mesocosm experiments conducted off the southern coast of mainland China indicate that phytoplank-

ton growth is limited by phosphorus, rather than nitrogen. In April, when natural seawater was enclosed in mesocosms, phosphorus always reached undetectable concentrations several days before inorganic nitrogen. This was not surprising since the initial N:P (by atoms) in the seawater at the start of the experiment was approximately 80:1, indicating about a five-fold excess nitrogen over phosphorus. Bioassay experiments also indicated P-limited phytoplankton growth for seawater in Xiamen Bay. Several other estuaries along the coast of China have N:P ratios ranging from 30:1 to greater than 80:1. The large rivers of China have high nutrient loads with nitrogen in great excess over phosphorus (e.g., N:P up to 150:1). As a consequence of these large riverine inputs, vast areas along the coast of China are P-limited for primary production. (Author's abstract)  
W91-01923

#### VARIATIONS IN STRUCTURE OF ESTUARINE FISH COMMUNITIES IN RELATION TO ABUNDANCE OF SUBMERSED VASCULAR PLANTS.

Maryland Dept. of Natural Resources, Annapolis.  
L. Lubbers, W. R. Boynton, and W. M. Kemp.  
Marine Ecology Progress Series MESEDT, Vol. 65, No. 1, p 1-14, July 19, 1990. 9 fig, 4 tab, 62 ref.  
EPA's Chesapeake Bay Program grant R8059322010.

Descriptors: \*Chesapeake Bay, \*Estuaries, \*Estuarine fisheries, Ecological distribution, Fish behavior, Fish diets, Fish populations, Macrophytes, Predation.

Fish communities and other ecological variables were sampled for 6 mo (May to October) in successive years (1979, 1980) at vegetated and non-vegetated areas in 2 distinctively different littoral zones (an open bay and a protected cove) of mid-salinity Chesapeake Bay. Fish abundance, biomass and species richness were higher in vegetated areas at both sites, and were significantly correlated with macrophyte biomass. Diel patterns of fish abundance varied, but highest catches generally occurred at dusk or at night. At one sampling site, fish assemblages were dominated by smaller individuals in the vegetated area, suggesting an attraction of juveniles to macrophyte beds for food or refuge from predation. Larger piscivorous fish, which were also caught in greater numbers in vegetated areas, may have been attracted there by higher densities of forage fish. At the cove site, the biomass of *Paleomonetes* sp. was comparable to that of the fish community towards the end of the plant growing season. Benthic infauna were also more abundant in vegetated areas at both sites, and stomach analyses indicated these organisms to be the dominant food resources for common fishes. Diets were generally non-selective in non-vegetated areas while highly selective for epiphytic fauna in macrophyte beds. Fish stomachs were also significantly fuller in vegetated areas, indicating generally greater feeding success. Fish production varied among major species but was higher overall at vegetated areas, following the seasonal patterns of primary production. Most of the differences in fish production between areas were attributable to higher instantaneous growth rates rather than higher biomass. It appears that the greater abundance and species richness of fish assemblages in vegetated areas of this region of the Chesapeake Bay resulted from the attractiveness of these habitats as rich sources of preferred foods. (Author's abstract)  
W91-01926

#### SEASONAL AND TIDAL ABUNDANCE OF CRAB LARVAE IN A TROPICAL MANGROVE SYSTEM, GULF OF NICOYA, COSTA RICA.

Delaware Univ., Newark. Coll. of Marine Studies.  
A. I. Dittel, and C. E. Epifanio.  
Marine Ecology Progress Series MESEDT, Vol. 65, No. 1, p 25-34, July 19, 1990. 4 fig, 6 tab, 63 ref.  
NSF grant INT-8613439 and Universidad de Costa Rica.

Descriptors: \*Costa Rica, \*Crabs, \*Estuaries, \*Gulf of Nicoya, \*Mangrove swamps, \*Tides, \*Wetlands, Life cycles, Population dynamics, Seasonal variation, Tidal currents.

Crab larvae were collected from a platform moored in the mouth of a mangrove tidal creek in the Gulf of Nicoya on the Pacific coast of Costa Rica, Central America. Eight observation periods encompassed both spring and neap tides and covered all seasons of the year. During each observation period, samples were collected every 2 h over 5 consecutive tidal cycles. Samples were collected from a depth of 1 m with a gasoline-powered impeller pump; total volume of each sample was 10 to 12 cu meters cubed. The gross taxonomic composition of the observed larval assemblage was similar to that seen in temperate estuaries along the Atlantic coast of North America. Larvae of *Uca* spp., *Grapsidae*, *Xanthidae* and commensal crabs such as *Pinnotheres* spp. were the most common forms in excess of 1000 larvae per cu meters. In contrast to temperate estuaries, spawning occurred year-round, but individual taxa showed distinct seasonality. As in temperate estuaries, spawning in the tidal creek was also influenced by lunar cycles and larvae of several taxa showed tidally rhythmic changes in abundance. Zoea I of *Uca* spp., *Grapsidae*, *Xanthidae*, *Pinnotheres* spp. and *Petrolisthes* spp. were significantly more abundant during ebb tides suggesting that these larvae were spawned in the creek and exported to the open Gulf. Advanced zoea and megalopae appeared to take advantage of nocturnal flood tides to be recruited back into the estuary. Export of early stages did not occur in all taxa. Abundance of early zoeal stages of *Pinnixa* spp. was not affected by tidal phase suggesting that early stages were not exported from the tidal creek. (Author's abstract)  
W91-01927

#### NATURAL ABUNDANCE OF 15N IN PARTICULATE NITROGEN AND ZOOPLANKTON IN THE CHESAPEAKE BAY.

Harvard Univ., Cambridge, MA. Museum of Comparative Zoology.  
J. P. Montoya, S. G. Horrigan, and J. J. McCarthy.

Marine Ecology Progress Series MESEDT, Vol. 65, No. 1, p 35-61, July 19, 1990. 7 fig, 13 tab, 36 ref. NSF grants OCE-82-14932 and OCE-86-14199.

Descriptors: \*Chesapeake Bay, \*Estuaries, \*Estuarine environment, \*Nitrogen, \*Zooplankton, Inorganic nitrogen, Particulate nitrogen, Phytoplankton, Seasonal variation, Trophic level.

Samples of dissolved inorganic nitrogen (DIN), particulate nitrogen (PN), and several species of zooplankton were collected at a series of stations in the main channel of the Chesapeake Bay, during cruises in spring and fall 1984. The spatial and temporal variation in the natural abundance of  $\delta^{15}\text{N}$  (delta N15) in each of these pools, in combination with measurements of the concentrations of DIN, PN, plant pigments, and the rates of biologically-mediated transformations of nitrogen, provide a number of insights into the dynamics of the nitrogen cycle in the Chesapeake Bay. The overall gradient of DIN concentrations along the axis of the Bay appears to be less important than local processes in determining the distribution of N15 in PN. The relationship between delta N15 of PN and delta N15 of dissolved pools indicated that phytoplankton uptake was the dominant process acting on DIN in Spring, but that microbially-mediated transformations of nitrogen dominated in the fall. During both seasons, delta N15 of particulate and dissolved pools suggested that phytoplankton consume both  $\text{NO}_3^-$  and  $\text{NH}_4^+$  roughly in proportion to concentration. The delta N15 of the zooplankton species sampled generally increased with trophic level. The spatial variability of delta N15 of all 3 trophic levels (PN, copepods, and ctenophores) was greater in spring than in fall, suggesting that phytoplankton and zooplankton have a greater direct influence on the estuarine nitrogen cycle during spring. A comparison of the 2 transects conducted on each cruise demonstrates that delta N15 of nitrogen of the PN and A. tonsa, but not that of M. leidyi, can change markedly on a time scale of roughly a week. Such changes clearly indicate that repeated sampling may be essential in studies of the natural abundance of N15 in dynamic planktonic systems such as that in the Chesapeake Bay. (Author's abstract)

## Field 2—WATER CYCLE

### Group 2L—Estuaries

W91-01928

#### PELAGIC METABOLISM IN EUTROPHIC WATERS DURING A LATE SUMMER PERIOD.

Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.  
K. Sand-Jensen, L. M. Jensen, S. Marcher, and M. Hansen.

Marine Ecology Progress Series MESEDT, Vol. 65, No. 1, p 63-72, July 19, 1990. 2 fig, 5 tab, 49 ref.

Descriptors: \*Bacteria, \*Denmark, \*Eutrophic fjords, \*Fjords, \*Phytoplankton, \*Primary productivity, Biomass, Eutrophication, Metabolism, Organic matter, Respiration.

Phytoplankton and bacterial biomass were measured at weekly intervals during summer in water samples from 2 sites in the shallow, eutrophic Roskilde Fjord, Denmark. In addition O<sub>2</sub>-uptake on unfiltered water and size fractions < 100 micrometers and < 1 micrometers was measured. Phytoplankton gross production in the water column was 6.2 g O<sub>2</sub>/sq m/d at Stn 1 and was balanced by pelagic community respiration and sediment respiration. Phytoplankton gross respiration was temporarily exceeded by pelagic community respiration plus sediment respiration at Stn 2 where there is additional production by littoral plant communities. Phytoplankton and bacteria together accounted for 72 to 85% of community respiration (R<sub>c</sub>) and zooplankton for the remainder. Phytoplankton respired a large proportion (ca 30%) of their gross production and were apparently mainly grazed by benthic suspension feeders. Phytoplankton dominated pelagic respiration (50% of R<sub>c</sub>) at Stn 1, which has the most phytoplankton, while bacteria dominated (44% of R<sub>c</sub>) at Stn 2. The relatively larger respiratory activity of bacteria at Stn 2 is ascribed to an additional supply of organic matter from littoral plant communities and frequent sediment suspension. The importance of bacteria in the pelagic food web was supported by other findings. Bacterial biomass approached phytoplankton carbon biomass at Stn 2 and bacterial net production and respiration were linearly related in the bacterial size-fraction (< 1 micrometer) with a bacterial growth yield of 47%. It is argued that the conversion factors applied to calculate bacterial net production and the mean growth yield attained are reasonable values considering the other measurements of pelagic carbon pools and processes. (Author's abstract)

W91-01929

#### DIEL VARIATIONS IN PHOTOSYNTHETIC ACTIVITY OF SUMMER PHYTOPLANKTON IN LINDASPOLLENE, WESTERN NORWAY.

Norsk Inst. for Vannforskning, Oslo.

S. R. Erga, and H. R. Skjoldal.

Marine Ecology Progress Series MESEDT, Vol. 65, No. 1, p 73-85, July 19, 1990. 9 fig, 2 tab, 90 ref. Norwegian Marine Pollution Research and Monitoring Program.

Descriptors: \*Diurnal variation, \*Fjords, \*Norway, \*Photosynthesis, \*Phytoplankton, Correlation analysis, Depth, Light, Lindaspollene, Nutrients, Primary productivity.

Diel patterns in photosynthesis of natural phytoplankton were studied during a 5 d period during midsummer in Lindaspollene, a land-locked fjord of western Norway. Samples were taken from depths of 0.5, 5, 10 and 21 m at 3 to 4 h intervals. The natural light-dark cycle was 19:5 h. The coccolithophorid *Emiliania huxleyi* and ultraplankton (< 5 micrometer) flagellates were predominant in the upper 10 m, while diatoms and silicoflagellates were predominant at 21 m. No clear diel pattern was seen in the variations of chlorophyll a and cell numbers. The photosynthesis vs. light relationship (P-I) was studied at 0.5 and 10 m, and the parameters P<sub>Bmax</sub> (specific production rate at optimal light intensity) alpha B (initial slope of the light saturation curve) and I<sub>k</sub> (irradiance at which the prolongation of the initial and horizontal parts of the parts of the photosynthesis curve intersect) showed pronounced diel rhythms. Maximum and minimum values of alpha B and P<sub>Bmax</sub> differed by

a factor of 3 to 4 and occurred in the morning and evening periods, respectively. These parameters were linearly correlated at both 0.5 and 10 m, indicating a phased diel periodicity. I<sub>k</sub> showed a clear diel variation at 0.5 m with minimum values at night, whereas no persistent diel rhythm could be seen at 10 m. P<sub>Bmax</sub> and I<sub>k</sub> were correlated at 0.5 m but not at 10 m, while I<sub>k</sub> and alpha B were weakly correlated at both 0.5 and 10 m. In vivo fluorescence per unit chlorophyll a showed a diel variation pattern that was the opposite to that of P<sub>Bmax</sub> and alpha B. The results indicate that an endogenous rhythm is regulating the diel oscillations in photosynthesis. This endogenous mechanism is possibly entrained by environmental signals such as cycles in nutrient availability and light conditions. (Author's abstract)

W91-01930

#### INCORPORATION OF THYMIDINE, ADENINE AND LEUCINE INTO NATURAL BACTERIAL ASSEMBLAGES.

Vandkvalitetsinstituttet, Hoersholm (Denmark).

B. Riemann, R. T. Bell, and N. O. G. Jorgensen. Marine Ecology Progress Series MESEDT, Vol. 65, No. 1, p 87-94, July 19, 1990. 2 fig, 3 tab, 51 ref. Carlsburg Foundation grant 87-0358/40 and Danish National Science Research Council grant 41-0003.

Descriptors: \*Adenine, \*Amino acids, \*Bacterial physiology, \*Deoxyribonucleic acid, \*Leucine, \*Primary production, \*Thymidine, Culture techniques, Growth rates, Incorporation rates.

Incorporation of H<sup>3</sup>-thymidine and H<sup>3</sup>-adenine into DNA and H<sup>3</sup>-leucine into protein were measured in diluted batch cultures of natural assemblages of coastal marine and freshwater bacteria. Incorporation rates of DNA and protein synthesis were compared with changes in bacterial DNA and carbon pools. Incorporation rates of all three substances peaked before maximum cell densities were reached. H<sup>3</sup>-leucine incorporation was somewhat higher than both H<sup>3</sup>-thymidine and H<sup>3</sup>-adenine incorporation during early exponential and stationary growth periods. The molar ratio of incorporated H<sup>3</sup>-adenine and H<sup>3</sup>-thymidine was 1:1 in freshwater and 3:1 in seawater cultures, and the cellular DNA content ranged from 2 to 4 fg per cell, corresponding to an average of 5.5% of cell carbon. DNA contents predicted from incorporation rates of adenine were 66 to 86% and of thymidine 28 to 77% of the measured DNA content. Conversion factors to derive bacterial cell numbers were 0.85 to 1.75 times 10 to the 18th power cells per mol thymidine incorporated and 0.47 to 0.92 times 10 to the 18th power cells per mol adenine incorporated. Carbon production predicted from incorporation rates of H<sup>3</sup>-thymidine, H<sup>3</sup>-adenine or H<sup>3</sup>-leucine differed by at most 31% from measured carbon production, suggesting that all three methods were applicable to determine growth rates and carbon production in the batch cultures. (Author's abstract)

W91-01931

#### UNUSUAL MARINE ECOSYSTEM IN THE FLOODED CRATER OF USHISHER VOLCANO.

Akademiya Nauk SSSR, Vladivostok. Inst. Biologii Morya.

A. V. Zhirmunsky, and V. G. Tarasov. Marine Ecology Progress Series MESEDT, Vol. 65, No. 1, p 95-102, July 19, 1990. 9 fig, 22 ref.

Descriptors: \*Heavy metals, \*Marine biology, \*Sulfur compounds, \*Volcanoes, Algae, Bacteria, Chemical properties, Macroinvertebrates, Photosynthesis, Physiology, Ushisher volcano.

A marine ecosystem in Kraternaya Bight (Yankich Island, Kurile Islands) which has arisen and is functioning under the influence of gaso-hydrothermal vents of the Ushisher volcano was studied. The concentrations of reduced sulfur compounds and a number of metals in the vents are 2 to 3 orders of magnitude higher than in seawater around the island. Together with the photosynthesis of algae, chemosynthetic bacteria play an essential part in primary production. Extreme chemical

conditions in the outlets of vents have left a mark on the composition of communities and in peculiarities of certain species. Organisms (some of the dominant species) which have colonized Kraternaya Bight have changed in morphology and adapted to extreme conditions. They have essentially changed some of their biochemical characteristics: they have a high content of the cytochrome P-450, 5-aminolevulinic synthetase and high rate of the level oxidizing in the microsomal system. Concentrations of some metals are so high that ecosystems of Kraternaya Bight can be considered as a model of sea territory with a high degree of industrial pollution. At the request of the Institute of Marine Biology, a biological preserve in Kraternaya Bight has been established. (Fleishman-PTT)

W91-01932

#### MUD BALANCE FOR BELGIAN-DUTCH COASTAL WATERS BETWEEN 1969 AND 1986.

Rijkswaterstaat, Rijswijk (Netherlands). North Sea Directorate.

For primary bibliographic entry see Field 2J.

W91-01934

#### DENITRIFICATION AND NITROUS OXIDE IN THE NORTH SEA.

Plymouth Marine Lab. (England).

For primary bibliographic entry see Field 5B.

W91-01935

#### WINTER DISTRIBUTION OF NUTRIENTS IN THE SOUTHERN BIGHT OF THE NORTH SEA (1961-1978) AND IN ESTUARIES OF THE SHELDT AND THE RHINE/MEUSE.

Nederlands Inst. voor Onderzoek der Zee, Texel. A. J. Van Bennekom, and F. J. Westeijn.

Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 1/2, p 75-87, May 1990. 14 fig, 2 tab, 36 ref.

Descriptors: \*Nitrate, \*North Sea, \*Nutrient concentrations, \*Phosphates, \*Rhine/Meuse Estuary, \*Scheldt Estuary, Phytoplankton, Seasonal distribution, Silica, Tracers, Wind-driven currents.

The winter distribution of nutrients in the eastern part of the Southern Bight is influenced by phytoplankton growth, always in February, sometimes in January. The Scheldt river has higher nutrient concentrations than the rivers Rhine and Seine. The waters of the Scheldt river plume are distinguished from those of the Seine and the Rhine/Meuse using dissolved silica as a tracer. The extension of the Scheldt river plume was related to wind direction. The increase of inorganic nutrients from January 1961 to January 1978 in the northern part of the Southern Bight was related to the nutrient increase in the river Rhine. The increase in the Strait of Dover was related to discharges from the river Seine and the English coast. Only data outside the Scheldt river plume were selected for comparison. An increase of nutrient concentrations was measurable over the entire salinity range and was largest for phosphate (up to 3 times at low salinities), less for nitrate (about 1.5 times for all salinities) and hardly noticeable for silicic acid. Nitrate extrapolation to low salinity agreed with upstream river values, but phosphate extrapolation gave higher concentrations, probably due to discharges of phosphogypsum in estuaries. (Author's abstract)

W91-01936

#### PHYTOPLANKTON BIOMASS AND POTENTIAL NUTRIENT LIMITATION OF PHYTOPLANKTON DEVELOPMENT IN THE SOUTHEASTERN NORTH SEA IN SPRING 1985 AND 1986.

Biologische Anstalt Helgoland (Germany, F.R.) E. Bauerfeind, W. Hickel, U. Niermann, and H. V. Westernhagen.

Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 1/2, p 131-142, May 1990. 3 fig, 1 tab, 53 ref.

## Saline Water Conversion—Group 3A

Descriptors: \*Coastal waters, \*Diatoms, \*Limiting nutrients, \*North Sea, \*Phytoplankton, Biomass, Carbon, Nitrogen, Phosphates, Silicates.

The vernal phytoplankton bloom was observed during cruises to the southeastern part of the North Sea in 1985 and 1986. Maximum phytoplankton biomass expressed as phytoplankton carbon was similar in both years. In 1985 the bloom was located in the less saline coastal water close to the North Frisian coast. Phytoplankton was dominated by *Coscinodiscus concinnus* and *Thalassiosira nordenskiöldii*. In 1986, highest phytoplankton biomass was observed northwest of the island of Sylt, where *Thalassiosira nordenskiöldii* was the dominant phytoplankton species. Within areas of high phytoplankton standing stock, concentrations of the inorganic dissolved nutrients phosphate and silicate had dropped to nearly undetectable concentrations, whereas both in 1985 and 1986 the water was still rich in organic nitrogen. This, as well as the high ratios of DIN:PO<sub>4</sub> and DIN:Si(OH)<sub>4</sub> (> 50) point to phosphate and silicate as potential limiting nutrients during the spring phytoplankton bloom. The ratios of total nitrogen (TN) to total phosphorus (TP) (> 30) indicate also that phosphorus might then be in short supply. Phosphate and silicate have to be considered as potentially limiting nutrients during the vernal plankton bloom in the coastal waters of the southeastern North Sea, with nitrogen being present in surplus at that time of year. However, in the more offshore areas nitrogen may be considered the potentially limiting element at the same time. (Author's abstract)  
W91-01937

#### PRIMARY PRODUCTION AND NITROGEN ASSIMILATION IN THE NORTH SEA DURING JULY 1987.

Plymouth Marine Lab. (England).  
N. J. P. Owens, E. M. S. Woodward, J. Aiken, I. E. Bellan, and A. P. Rees.  
Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 1/2, p 143-154, May 1990. 7 fig, 30 ref.

Descriptors: \*Coastal waters, \*Denitrification, \*Nitrogen, \*North Sea, \*Primary production, Ammonium, Carbon, Chlorophyll, Nutrient concentrations, Phytoplankton.

Surface water inorganic nutrient concentrations and concomitant rates of primary production (C-14) and nitrogen assimilation (N-15) were measured in the North Sea in July 1987. Primary production was investigated using size fractionation techniques. Three vertical profiles of primary production and nitrogen assimilation were also investigated. Much of the North Sea exhibited thermal stratification. Surface nutrient concentrations were low and chlorophyll concentrations typically <1 mg per meter cubed. More than 75% of the primary production was attributable to cells <5 micrometers in diameter. Ammonium assimilation accounted for most of the nitrogen assimilation. The water column was vertically well mixed in the coastal zones. Here, inorganic nitrogen concentrations were high with chlorophyll concentrations up to 10 per mg cubed, and organisms >5 micrometers in diameter accounted for most of the primary production. As in offshore regions, ammonium accounted for the major part of the nitrogen assimilated. A 115 km section obtained using an undulating oceanographic recorder showed that in certain regions of the North Sea physical features acted to increase the dependence of the phytoplankton on nitrate. (Author's abstract)  
W91-01938

#### CHANGES IN SPATIAL DISTRIBUTION OF PRIMARY PRODUCTION, PHOTOSYNTHETIC PIGMENTS AND PHYTOPLANKTON SPECIES COMPOSITION DURING TWO SURVEYS IN THE GERMAN BIGHT.

Rijkswaterstaat, The Hague (Netherlands). Div. of Tidal Waters.  
F. Colijn, L. Villerius, M. Rademaker, K. D. Hammer, and K. Eberlein.  
Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 1/2, p 155-164, May 1990. 11 fig, 2

tab, 33 ref.

Descriptors: \*Chlorophyll, \*North Sea, \*Phytoplankton, \*Pigments, \*Primary production, Diatoms, Flagellates, German Bight, Nutrients, Spatial distribution, Species composition.

A grid of 61 stations was sampled twice in the German Bight. At all stations dissolved nutrients (Si, P, N), fluorescence, temperature and salinity were measured along the vertical at surface, 5 m, 10 m, and 10 m intervals to the bottom. At selected stations, photosynthetic rates were measured with C-14 method (both surveys) and pigment with a HPLC method (first survey). Phytoplankton species composition was dominated by small diatoms, mainly *Leptocylindrus minimus*, flagellates, both dinoflagellates and choanoflagellates and near shore blooms of *Phaeocystis pouchetii*. Primary production and chlorophyll-a showed a linear correlation ( $r=0.90$ ,  $n=23$ ). Primary production showed highest rates along the North and East Frisian islands, where phytoplankton was dominated by *Phaeocystis* and *Leptocylindrus*. These coastal stations were completely mixed whereas a large part already showed stratification due to salinity and temperature. Thermocline and pycnocline were at about 10 m depth. No differences in oxygen content of surface or bottom waters were observed. Silicate and phosphate concentrations were very low whereas nitrogen still showed very high concentrations. Low hypolimnetic oxygen concentrations are only possible when transport of primary produced organic matter is transported to stratified regions later in summer. Rapid growth of blooms was observed within a weeks period. More primary production measurements in the German Bight should be done to allow for budget calculations of oxygen consumption below the thermocline. (Author's abstract)  
W91-01939

#### CHANGES IN SUBLITTORAL ZOOBENTHOS IN THE GERMAN BIGHT WITH REGARD TO EUTROPHICATION.

Alfred-Wegener-Inst. fuer Polar- und Meeresforschung, Bremerhaven (Germany, F.R.).  
For primary bibliographic entry see Field 5C.  
W91-01940

#### CONCENTRATIONS OF ORGANOCHLORINE COMPOUNDS IN THE HERMIT CRAB PAGURUS BERNHARDUS FROM THE GERMAN BIGHT, DECEMBER 1988 - MAY 1989.

Hamburg Univ. (Germany, F.R.). Inst. fuer Biochemie und Lebensmittelchemie.  
For primary bibliographic entry see Field 5B.  
W91-01941

#### SUPPLY AND DEPOSITION OF SEDIMENT ALONG THE NORTH BANK OF HANGZHOU BAY, CHINA.

East China Normal Univ., Shanghai. Inst. of Estuarine and Coastal Research.  
For primary bibliographic entry see Field 2J.  
W91-01942

#### EFFECT OF HEAVY METALS ON BAY SCALLOPS, SURF CLAMS, AND BLUE MUSSELS IN ACUTE AND LONG-TERM EXPOSURES.

National Marine Fisheries Service, Milford, CT. Milford Lab.  
For primary bibliographic entry see Field 5C.  
W91-01973

#### SIMULATION MODEL OF WATER DEPTH IN MANGROVE BASIN FORESTS.

Collier Mosquito Control District, Naples, FL. S. A. Ritchie.  
Journal of the American Mosquito Control Association JAMAET, Vol. 6, No. 2, p 213-222, June 1990. 6 fig, 1 tab, 10 ref.

Descriptors: \*Computer models, \*Hydrologic models, \*Mangrove swamps, \*Model studies, \*Simulation, \*Water depth, \*Wetlands, Calibrations, Hydrologic cycle, Hydrologic data, Mosquitoes, Rainfall.

The ability to understand and predict short and long-term mosquito abundance is a key to effective control of *Aedes taeniorhynchus* (Wiedemann), the black salt marsh mosquito. To help satisfy these goals, a hydrological model simulating the water depth within mangrove basin forests was constructed and validated. Rainfall, water table, water depth and tide data collected from a red mangrove basin forest on Marco Island, FL, was used to estimate model parameters. These included the basin spillover height, evapotranspiration-infiltration rate and the functional relationship of water depth change to rainfall, tide and basin spillover. The model was constructed with LOTUS 123 and calibrated from staff gauge water depth records. The model proved accurate and adaptable. Water depths from the model and staff gauge were highly correlated ( $r = 0.98$ ). Data from an adjacent black mangrove forest featuring complex wet-dry cycling were used to modify the model. After calibration, the model provided an accurate record of water depths at the site ( $r = 0.89$ ). This model will provide water depths used in a model of *Aedes taeniorhynchus* population dynamics. (Author's abstract)  
W91-01989

#### MASS-BALANCE OF METALS AND IDENTIFICATION OF THEIR SOURCES IN BOTH RIVER AND FALLOUT FLUXES NEAR GDANSK BAY, BALTIC SEA.

Akademia Medyczna, Gdansk (Poland). Dept. of Analytical Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-02007

#### RECENT TAXONOMIC DISCOVERIES CONCERNING THE MUSSEL MYTILUS: IMPLICATIONS FOR BIOMONITORING.

Memorial Univ. of Newfoundland, St. John's. Dept. of Earth Sciences.  
For primary bibliographic entry see Field 5A.  
W91-02030

### 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

#### 3A. Saline Water Conversion

#### RECOVERY OF MINERAL SALTS AND POTABLE WATER FROM DESALTING PLANT EFFLUENTS BY EVAPORATION: PART I. EVALUATION OF THE PHYSICAL PROPERTIES OF HIGHLY CONCENTRATED BRINES.

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Chemical Engineering.  
H. K. Abdel-Aal, K. M. Ba-Lubaid, D. K. Al-Harbi, and A. A. Shaikh.  
Separation Science and Technology STSTDS, Vol. 25, No. 3, p 309-321, 1990. 7 fig, 2 tab, 10 ref.

Descriptors: \*Brines, \*Desalination wastes, \*Drinking water, \*Evaporation, \*Reclaimed water, Flash evaporation, Industrial plants, Magnesium chloride, Sodium chloride, Solubility, Specific gravity.

The recovery of a salt (in particular, magnesium chloride) from rejected brines of desalination plants through the simulation of a modified Multistage Flash (MSF) evaporation system was studied. Such a proposal is attractive for countries highly dependent on water desalination. Saudi Arabia and other Arab Gulf states are good examples. A basic assumption underlying this study (both Part I and Part II) is that desalination effluents contain only the two most abundant salts in seawater: sodium and magnesium chlorides. An equilibrium relationship describing the solubility of sodium chloride in aqueous solutions of magnesium chloride is developed. This generalized correlation is based on the solubility data available in the literature. The correlation is valid for the temperature range 15-200 C and for a concentration of magnesium chloride up to 30 g/100 g saturated solution. Calculations of the specific gravity and viscosity of highly concen-

## Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

### Group 3A—Saline Water Conversion

trated brines are presented and then compared with experimental data. It is concluded that the solubility correlation is valid for predicting the solubility of sodium chloride in aqueous magnesium chloride solution for the indicated temperature and concentration ranges. An average deviation of less than 8% was calculated, except for a few points which probably had inherent experimental errors. For these specific points, the deviation was extremely high. (Agostine-PTT)  
W91-01757

**CHARACTERIZATION OF DESALTING CONCENTRATES.**  
Rostek Services, Inc., Fort Myers, FL.  
I. C. Watson.  
Desalination DSLNAH, Vol. 78, No. 1, p 5-9, July 1990. 3 tab.

Descriptors: \*Desalination wastes, \*Membrane processes, \*Reverse osmosis, \*Waste characteristics, \*Waste disposal, Chemical analysis, Desalination, Estimating, Florida, Heavy metals, Organic compounds.

With the recent rapid growth of desalting applications in Florida, the subject of desalting concentrate disposal has assumed a significant role. In order that the designer may realistically project expected concentrate characteristics, it is necessary to examine the various membrane processes involved. Typical compositions of concentrates produced from brackish water reverse osmosis, membrane softening and electrodialysis reversal methods are detailed. Use of the seawater reverse osmosis method may also be used in the future, due to its simple method of disposing concentrate by discharging it back into the sea. Desalting plant concentrate characteristics may be predicted with reasonable accuracy in the absence of actual test data. While software developed by the membrane manufacturers will predict the major ionic species, most of those components examined by the Florida Department of Environmental Regulation will have to be derived in theory. Several rules of thumb are given for the estimation of heavy metals, organics, and hydrogen sulfide, and for calculating the concentration factor. (VerNooy-PTT)  
W91-01766

**HISTORIC DEVELOPMENT OF THE CONCENTRATE REGULATIONS.**  
Stone and Webster Engineering Corp., Fort Lauderdale, FL.  
For primary bibliographic entry see Field 5G.  
W91-01977

**CURRENT REGULATORY CONCERNS RELATED TO THE DISPOSAL OF RO CONCENTRATES IN FLORIDA.**  
Florida State Dept. of Environmental Regulation, Tallahassee.  
For primary bibliographic entry see Field 5G.  
W91-01978

**SURFACE WATER DISCHARGE OF REVERSE OSMOSIS CONCENTRATES.**  
Post, Buckley, Schuh and Jernigan, Inc., Orlando, FL.  
For primary bibliographic entry see Field 5E.  
W91-01979

**DISPOSAL OF CONCENTRATE FROM BRACKISH WATER DESALTING PLANTS BY USE OF DEEP INJECTION WELLS.**  
For primary bibliographic entry see Field 5E.  
W91-01980

**IRRIGATION WITH MEMBRANE PLANT CONCENTRATE: FORT MYERS CASE STUDY.**  
Boyle Engineering Corp., Fort Myers, FL.  
For primary bibliographic entry see Field 3C.  
W91-01981

**USE OF SOLAR PONDS IN THE DISPOSAL OF DESALTING CONCENTRATE.**

California State Dept. of Water Resources, Fresno. Special Investigations Branch.  
For primary bibliographic entry see Field 5E.  
W91-01982

**DISPOSAL OF CONCENTRATES FROM BRACKISH WATER DESALTING PLANTS BY MEANS OF EVAPORATION TECHNOLOGY.**  
Bechtel National, Inc., Washington, DC.  
For primary bibliographic entry see Field 5E.  
W91-01983

**RECLAIMING REVERSE OSMOSIS BLOW-DOWN WITH ELECTRODIALYSIS REVERSAL.**  
Ionics, Inc., Watertown, MA.  
For primary bibliographic entry see Field 5D.  
W91-01984

**HIGH RECOVERY REVERSE OSMOSIS.**  
Stone and Webster Engineering Corp., Fort Lauderdale, FL.  
B. M. Watson.  
Desalination DSLNAH, Vol. 78, No. 1, p 91-97, July 1990. 5 fig.

Descriptors: \*Brines, \*Desalination, \*Desalination wastes, \*Feedwater treatment, \*Reverse osmosis, \*Scaling, \*Waste disposal, Liming, Pilot plants, Wastewater disposal.

The costs of transmission and disposal of reverse osmosis (RO) plant concentrates per unit of water production are directly related to brine volumes, which affect size of pipe, stripping towers, sedimentation basins, outfalls and/or injection wells, and any repumping required en route. These costs may be markedly reduced by increasing product recovery. As a means to minimize or eliminate brine disposal problems, high recovery RO must be accompanied by pre or post-treatment to avoid scale precipitation, almost entirely by calcium sulfate. All such methods, such as pretreatment by lime-soda softening, post-treatment by lime/lime-soda softening, and pretreatment by desulfation will add to water cost. However, rigorous comparison must be made with the costs and constraints of brine disposal at recoveries low enough not to require these treatments. Such examination is invariably and totally site-specific. Prior to detailed design of any large RO facility, it is always prudent to invest in a pilot plant testing program, whereby membrane performance under varying recovery and flux may be evaluated on the raw feed to be used at full scale. Because of the even tighter design limits imposed at high recovery, pilot tests of combined membrane and treatment processes are absolutely essential. (Author's abstract)  
W91-01985

### 3B. Water Yield Improvement

**META-ANALYTIC REAPPRAISAL OF STATISTICAL RESULTS IN THE ENVIRONMENTAL SCIENCES: THE CASE OF A HYDROLOGICAL EFFECT OF CLOUD SEEDING.**  
Hebrew Univ. of Jerusalem (Israel). Inst. of Earth Sciences.  
D. Sharon.  
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 5, p 390-395, 1990. 2 fig, 2 tab, 9 ref.

Descriptors: \*Cloud seeding, \*Data interpretation, \*Hydrologic models, \*Model studies, \*Simulation analysis, \*Statistical analysis, \*Statistical methods, Experimental data, Israel, Meteorological data, Model testing, Streamflow forecasting.

A frequent problem in the statistical analysis of data in the environmental sciences is the synthesis of results obtained independently from various sets of data such as from different measuring points or from replicated experiments. Unlike their separate analysis, the sets' ultimate combined evaluation is often given in descriptive terms. The critical final stage of data synthesis is where meta-analysis is important. Meta-analysis offers a theoretical basis

for combining outcomes from a number of independent data sets, or replicated experiments, into one integrated result. It also provides an integrated significance test. The meta-analysis approach was applied to a cloud seeding project in Israel to determine the hydrological effect on stream and spring flow. The effectiveness of this approach was illustrated by means of a series of mostly positive primary results, which, however, were lacking significance when subjected to separate t-tests. In the case of rainfall enhancement in Israel, the lack of significance in primary tests had previously been considered overriding, whereas the meta-analytic combination of results came out distinctly significant. (Fish-PTT)  
W91-01470

**PERSISTENCE OF SEEDING EFFECTS IN A WINTER OROGRAPHIC CLOUD SEEDING WITH SILVER IODIDE BURNED IN ACETONE.**  
Bureau of Reclamation, Auburn, CA.  
T. Deshler, and D. W. Reynolds.  
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 6, p 477-488, 1990. 5 fig, 32 ref.

Descriptors: \*Cloud liquid water, \*Cloud seeding, \*Meteorological data, \*Orographic precipitation, \*Silver iodide, Aircraft, Atmospheric circulation, Ice, Isotopic tracers.

A number of experiments have focused on determining the physical effects of cloud seeding. Measurements in a cloud chamber indicate that an AgI NH<sub>4</sub> NH<sub>4</sub>CO<sub>3</sub> mixture will produce detectable levels of ice crystals in clouds as warm as -6 °C. Also the AgI is useful as a tracer since it can be measured with an ice nucleus counter. Seeding material was identified and tracked in a wintertime, fairly shallow, stratiform cloud over the central Sierra Nevada with the use of a research aircraft. The effects of aerial seeding with the silver iodide mixture were observed to persist for over 90 min after seeding and 100 km downwind of the seedline. The aircraft was able to locate and track the line source of AgI using an ice nucleus counter. High ice crystal concentrations due to seeding were not apparent until more than one hour after seeding. This may have been partially due to the high natural concentrations of ice, but post-mission analysis revealed that most sampling passes during the first hour following seeding were made below the AgI seeded volume. Ice nucleus measurements confirmed sampling of the seedline from 1-1.5 h after seeding, with associated increases in ice crystal concentrations. The effectiveness of the seeding material in the field was higher than laboratory measurements would suggest. (Fish-PTT)  
W91-01473

**NEW GENE SOURCES FOR DEVELOPMENT OF AGRONOMIC PLANTS WITH TOLERANCE TO DROUGHT AND OTHER ABIOTIC STRESSES.**

New Mexico State Univ., Las Cruces. Dept. of Chemistry.  
G. D. Kuehn.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-140229/AS. Price codes: A04 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report No. 247, November 1989. 60p, 15 fig, 7 tab, 106 ref. USGS Contract No. 14-08-0001-G1438-05. USGS State Project No. 1423618 and 1423698.

Descriptors: \*Drought resistance, \*Genetic engineering, \*Plant physiology, \*Plant-water relationships, \*Proteins, Abiotic stresses, Alfalfa, Cotton, Plant stress, Thermophilic eubacteria, Uncommon polyamines.

This project was an investigation in plant biochemistry/molecular biology/molecular genetics directed toward saving water through the development of water-conserving plants. The central, specific objective was to determine whether the thermophilic eubacterium, *Thermus thermophilus* HB8, produced one specific enzyme protein responsible for the biosynthesis of a class of compounds newly

## Use Of Water Of Impaired Quality—Group 3C

discovered in higher plants called uncommon polyamines. Uncommon polyamines may be protectants against abiotic stresses such as drought and heat. The rationale of the project was that if the central objective could be achieved, then the gene in *T. thermophilus* which produced the unique enzyme protein would be a valuable objective for cloning and transfer from the bacterium to plants using recombinant DNA methods. This transfer might confer improved tolerances in plants towards drought and heat stresses. The major conclusions of the project were the following: (1) Numerous criteria based on purification trials of the protein from *T. thermophilus* indicated that one unique protein is responsible for all uncommon polyamine biosyntheses; (2) The enzyme protein demonstrated extraordinary catalytic efficiency indicating that it would be an excellent candidate for isolation of its gene and its transfer to plants; (3) Unexpectedly, plants themselves were discovered to produce this enzyme protein and the uncommon polyamines in preselected drought-tolerant alfalfa and heat-tolerant cotton strains and; (4) Metabolic inhibitors were identified which could be exploited to develop cell selection protocols which may yield crop plants with improved drought tolerances. (USGS)  
W91-01859

## 3C. Use Of Water Of Impaired Quality

## EFFECT OF IRRIGATION WITH SEWAGE EFFLUENT ON DECOMPOSITION OF LITTER IN PINUS RADIATA FORESTS.

New Zealand Forest Service, Rotorua. Forest Research Inst.  
T. G. Baker, W. J. Dyck, P. G. Barton, G. R. Oliver, and G. Nicholson.  
Forest Ecology and Management FECMDW, Vol. 31, No. 4, p 205-214, April 1990. 2 fig, 4 tab, 21 ref.

Descriptors: \*Detritus, \*Organic matter, \*Pine trees, \*Wastewater disposal, \*Wastewater irrigation, \*Water pollution effects, Calcium, Forests, Hydrogen ion concentration, Magnesium, Phosphorus, Spray irrigation.

Two *Pinus radiata* D. Don forests (aged 18 and 25 years) were spray irrigated for 32 months with domestic sewage effluent from a secondary oxidation pond. Effluent was applied at rates of 25 and 50 mm/wk. Irrigation decreased litter organic matter by 43%-57% but there was no change in organic matter in the soil (0-50 mm). Annual loss constants determined from a litter bag study in one forest approached 1.0 in the irrigated plots, compared to 0.48 in the control. Irrigation increased the pH and the availability of P, Ca and Mg in the soil. Increased concentrations of N, P, Ca, and Mg in irrigated litterbags were closely correlated with increases in the rate of decomposition of the organic matter. The effect of irrigation on decomposition was due, in part, to the maintenance throughout the year of a more suitable environment in the litter for decomposers, particularly during dry summer periods. (Author's abstract)  
W91-01067

## DIFFERENTIAL RESPONSE OF WHEAT AND BARLEY GENOTYPES TO SUBSTRATE-INDUCED SALINITY UNDER NORTH INDIAN CONDITIONS.

Govind Ballabh Pant Univ. of Agriculture and Technology, Pantnagar (India). Dept. of Agronomy.  
K. P. Prabhakaran Nair, and N. C. Khulbe.  
Experimental Agriculture EXAGAL, Vol. 26, No. 2, p 221-225, April 1990. 4 tab, 8 ref.

Descriptors: \*Barley, \*India, \*Irrigation effects, \*Saline soils, \*Salt stress, \*Salt tolerance, \*Wheat, Altitude, Climates, Crop yield, Genotypes, Irrigation, Plant reproduction, Salinity, Water use efficiency.

A crucial problem in low altitude agriculture is the shortage of adequate agricultural land. In India, about seven million hectares of salt-affected land adjacent to irrigation systems pose a potential

threat to the quality of the irrigation water. Ten wheat and barley genotypes were tested for their response to soil salinity regimes varying from 0 to 16 mmhos/cm. Barley showed remarkable resistance to salt stress, linked to its capability to resist efflux of potassium ions from the plant system. Both crops showed substantial yield reductions at 12 mmhos/cm, but barley still outyielded wheat by over 50%. There were significant interactions between salinity levels and genotypes in wheat but not in barley. The wheat variety Sonalika showed poor salt tolerance. The implications of these findings in breeding salt-tolerant varieties are the possibility of reclaiming salt-affected land by seeking salt tolerant crops for use on these soils. This investigation shows that long term and sustainable approaches to combat salt affected lands in India require a switch from conventional breeding for yield strategies to those of selection for tolerance to salt stress. (Brunone-PTT)  
W91-01113

## EFFECTS OF SALINE WATER IRRIGATION ON GROWTH AND MINERAL DISTRIBUTION IN GUAR (CYAMOPSIS TETRAGONOLOBA (L.) TAUB).

Karachi Univ. (Pakistan). Dept. of Botany.  
D. Khan, R. Ahmad, S. Ismail, and S. H. Zaheer.  
Pakistan Journal of Botany PJBOB6, Vol. 21, No. 2, p 290-301, December 1989. 5 fig, 3 tab, 22 ref.

Descriptors: \*Guar, \*Plant growth, \*Saline water irrigation, \*Salt stress, Calcium, Potassium, Sodium.

Growth and mineral distribution of a local strain of guar (*Cyamopsis tetragonoloba* (L.) Taub) were investigated in relation to salinity. Growth in terms of height and dry matter of different plant parts decreased significantly under salinity. Threshold ECiw inducing 50% reduction in seed production was 5.76 dS/m. Net reproductive effort of the plants treated with 30‰ sea water was 10.85%, as compared to 27.32% in control. Salinity decreased the number of pods and seeds per plant, whereas, the number of seeds per pod were unaffected and averaged around 7-8 seeds. Distribution of seeds among pods was leptokurtic in all the cases but with salinity variance increased and distribution tended to be more negatively skewed. Absorption of Na<sup>+</sup> and K<sup>+</sup> increased with salinity, whereas K<sup>+</sup> declined at high salinity. Absorption of these ions was almost equal at 20‰ sea water treatment. Ca<sup>++</sup> absorption although declined with salinity, Mg<sup>++</sup> behaved indifferently. Distribution patterns of ions showed that plant responded to salinity by excluding ions from reproductive parts specifically from the seeds. All cations were generally more allocated in leaves. (Author's abstract)  
W91-01149

## REMOVAL OF ORGANOHALOGENS AND ORGANOHALOGEN PRECURSORS IN RECLAIMED WASTEWATER-I.

California Univ., Los Angeles. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5D.  
W91-01415

## REMOVAL OF ORGANOHALOGENS AND ORGANOHALOGEN PRECURSORS IN RECLAIMED WASTEWATER-II.

California Univ., Los Angeles. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5D.  
W91-01416

## RECOVERY OF MINERAL SALTS AND POTABLE WATER FROM DESALTING PLANT EFFLUENTS BY EVAPORATION: PART I. EVALUATION OF THE PHYSICAL PROPERTIES OF HIGHLY CONCENTRATED BRINES.

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Chemical Engineering.  
For primary bibliographic entry see Field 3A.  
W91-01757

## NEW GENE SOURCES FOR DEVELOPMENT OF AGRONOMIC PLANTS WITH TOLERANCE TO DROUGHT AND OTHER ABIOTIC STRESSES.

New Mexico State Univ., Las Cruces. Dept. of Chemistry  
For primary bibliographic entry see Field 3B.  
W91-01859

## MICROALGAE PRODUCTION AND SHELLFISH FEEDING TRIALS AT THE ROSWELL TEST FACILITY.

New Mexico State Univ., Las Cruces. Southwest Technology Development Inst.  
B. Goldstein.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-2223164/AS. Price codes: A05 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces, Technical Completion Report No. 249, March 1990. 68p, 29 fig, 5 tab, 21 ref. USGS Contract No. 14-08-0001-G1438. USGS State Project No. 1423695 and 1423659.

Descriptors: \*Aquaculture, \*New Mexico, \*Shellfish farming, Algae, Algal growth rate, Algal productivity, Clams, Microalgae, Mollusks, Oysters, Saline water.

It has been demonstrated that several microalgae species, which are thought to be good food for feeders, will survive and grow in Roswell Test Facility (RTF) saline groundwater at pilot scale (50 cu m raceways). Under specific environmental and cultural conditions, several species of shellfish have demonstrated excellent survival and growth. However, the productivity and cultural stability of algae are greatly diminished during cold months of the year in Roswell (October to March). The potential for commercial production of bivalve mollusks in saline groundwater in southern New Mexico is great if a site can be found that has a source of geothermal water for heating purposes and a source of saline water that will support the growth of marine species. A concerted effort should be made to locate such sites, and to construct and operate a large pilot-scale facility at the site. Simultaneously, algae and shellfish should continue to be grown at pilot scale in Roswell to demonstrate the technical feasibility to the private sector and to optimize methods for growing marine organisms hundreds of miles from the nearest ocean. (USGS)  
W91-01867

## IRRIGATION WITH MEMBRANE PLANT CONCENTRATE: FORT MYERS CASE STUDY.

Boyle Engineering Corp., Fort Myers, FL.  
E. Edwards, and P. Bowdoin.  
Desalination DSLNAH, Vol. 78, No. 1, p 49-58, July 1990. 4 tab, 3 ref.

Descriptors: \*Case studies, \*Desalination wastes, \*Irrigation water, \*Land disposal, \*Membrane processes, \*Salinity, \*Waste disposal, \*Wastewater irrigation, \*Water treatment wastes, Desalination, Dissolved solids, Drainage water, Florida, Golf courses, Reverse osmosis, Salt tolerance, Trace elements, Wastewater disposal, Water quality data.

Use of irrigation as the primary disposal method of membrane plant concentrate becomes more difficult as the salinity and total dissolved solids (TDS) of the feedwaters increase beyond the freshwater levels. Crop tolerances to specific ions become of greater concern. Blending with suitable irrigation water supplies is a means of decreasing the applied salinity and TDS concentrations. Guidelines for interpretation of water quality for irrigation are discussed, along with a list of recommended maximum trace element levels in irrigation waters. A case study was made of the Fort Myers membrane softening plant. Water quality data was obtained and analyzed for the feed and reject water (concentrate) from the pilot scale testing plant on June 22, 1988. One possible use for the waste concentrate is as a supplemental irrigation supply for the golf course located adjacent to the City's proposed water plant site. Excess concentrate not utilized for irrigation will be discharged off of the golf course site in accordance with the drainage plan of the course. Plans for use of concentrate from the pro-

## Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

### Group 3C—Use Of Water Of Impaired Quality

posed Fort Myers membrane softening plant must encompass a wide variety of considerations including determination of the irrigation suitability of the concentrate without blending, a study of the potential impacts of introducing concentrate to the existing surface water, a study of the potential impact on groundwaters beyond projected zones of discharge, and a study of the potential impact from discharge of excess blended waters to the City's stormwater drainage system. The use of membrane softening concentrate as an irrigation supply appears feasible for the City of Fort Myers, based on generalized irrigation guidelines and applicable state water quality criteria. (VerNooy-PTT) W91-01981

### 3D. Conservation In Domestic and Municipal Use

**LEAKAGE CONTROL IN A UNIVERSALLY METERED DISTRIBUTION SYSTEM: PINE-TOWN WATER'S EXPERIENCE.**  
Pinetown Regional Water Services Corp., Natal (South Africa).  
R. E. Mills.  
Journal of the Institution of Water and Environmental Management JIWMZ, Vol. 4, No. 3, p 235-241, June 1990. 4 fig, 3 tab, 3 ref.

Descriptors: \*Leakage, \*South Africa, \*Water distribution, \*Water loss, \*Water metering, Computers, Cost analysis, Hydraulic valves, Minimum flow, Monitoring, Sounding, Water districts, Water pressure.

As a result of water losses reaching a high point of 16% in 1973, combined with a relatively high and increasing retail tariff, the Pinetown Regional Water Services Corporation (Natal, South Africa) embarked upon a program to reduce losses to an acceptable level of about 10%. The program involved: (i) the establishment of district metering throughout the distribution system; (ii) the replacement of certain retail meters; and (iii) the metering of new fire connections (other than those serving sprinkler installations). Further steps were taken to improve the situation and included monitoring of minimum night flows, regular sounding of distribution mains and the establishment of a full-time waste detection gang. Also with improved control valves becoming available, more effective pressure control of the system was achieved. The Corporation's computer was called upon to determine monthly losses from each of the hundred or so districts, the life history, in graphical form, of retail meters under review and a record of expenditure on leakage control. The development of methods used in leakage control (costing less than half a cent per cubic meter of water purchased) and practical experience gained in reducing losses from 15% to less than 5% over a period of 14 years resulted in a reduction in leakage losses and a better working knowledge of the distribution system. (Author's abstract) W91-01270

**INFRASTRUCTURE-WEATHERING A BOOM-AND-BUST DEVELOPMENT CYCLE.**  
Austin Water and Wastewater Utility, TX.  
For primary bibliographic entry see Field 6B. W91-01555

**URBAN CAPACITY SHARING: AN INNOVATIVE PROPERTY RIGHT FOR MATURING WATER ECONOMIES.**  
University of New England, Armidale (Australia). Centre for Water Policy Research.  
For primary bibliographic entry see Field 6E. W91-01632

### 3E. Conservation In Industry

**INDUSTRIAL PRETREATMENT: COOPERATION-TO A POINT...**  
Metropolitan Waste Control Commission, St. Paul, MN.  
For primary bibliographic entry see Field 5D.

W91-01565

### 3F. Conservation In Agriculture

**EFFECT OF CONVENTIONAL VS. NO-TILLAGE ON PESTICIDE LEACHING TO SHALLOW GROUNDWATER.**  
Agricultural Research Service, Beltsville, MD.  
For primary bibliographic entry see Field 5B. W91-01014

**NITRATE CONTAMINATION OF GROUNDWATER UNDER IRRIGATED COASTAL PLAIN SOILS.**  
Maryland Univ., College Park. Dept. of Agronomy.  
For primary bibliographic entry see Field 5B. W91-01015

**EFFECTS OF ACIDIC IRRIGATION ON SOIL MICROORGANISMS AT KEVO, NORTHERN FINLAND.**  
Turku Univ. (Finland). Dept. of Biology.  
For primary bibliographic entry see Field 5C. W91-01109

**DIFFERENTIAL RESPONSE OF WHEAT AND BARLEY GENOTYPES TO SUBSTRATE-INDUCED SALINITY UNDER NORTH INDIAN CONDITIONS.**  
Govind Ballabh Pant Univ. of Agriculture and Technology, Pantnagar (India). Dept. of Agronomy.  
For primary bibliographic entry see Field 3C. W91-01113

**EVAPOTRANSPIRATION, WATER USE EFFICIENCY, MOISTURE EXTRACTION PATTERN AND PLANT WATER RELATIONS OF RAPE (BRASSICA CAMPESTRIS) GENOTYPES IN RELATION TO ROOT DEVELOPMENT UNDER VARYING IRRIGATION SCHEDULES.**  
Haryana Agricultural Univ., Hissar (India).  
For primary bibliographic entry see Field 2D. W91-01114

**PREDICTING WATER USE AND WATER APPLICATION EFFICIENCIES FOR DIFFERENT IRRIGATION DEPTHS IN WHEAT.**  
Punjab Agricultural Univ., Ludhiana (India). Dept. of Soil and Water Engineering.  
V. K. Gupta, and N. K. Narda.  
International Journal of Tropical Agriculture IJTADD, Vol. 7, No. 1/2, p 34-40, March/June 1989. 3 tab, 10 ref.

Descriptors: \*Irrigation efficiency, \*Irrigation programs, \*Model studies, \*Water use efficiency, \*Wheat, Evaporation, Irrigation requirements, Plant physiology, Plant water potential, Soil water, Transpiration, Water management.

Optimal irrigation scheduling requires precise estimates of soil moisture status in the soil profile. Since soil moisture exerts a direct influence on the plant's physiological process, the daily prediction of soil moisture availability in the crop root zone is needed. A model is presented which, when given the inputs of soil, plant, and climatic parameters, predicts water use and soil moisture content in the wheat root zone. The daily estimates of evapotranspiration were obtained and separated into evaporation and transpiration. The transpiration was extracted from the soil profile depending on the rooting densities available in different soil layers. Daily transpiration values were added up to arrive at optimal irrigation schedules. The predicted values were quite close to the values observed in the fields for a range of water management options. Simulation runs of the model revealed that an optimal use of 37.5 cm of water during the season gave reasonably good water application efficiency. (Brunone-PTT) W91-01115

**EFFECT OF SCHEDULING IRRIGATION AND PHOSPHORUS LEVELS ON YIELD OF PIGEONPEA IN GANG COMMAND AREA.**  
Rajasthan Coll. of Agriculture, Udaipur (India). Dept. of Agronomy.  
M. Lal, and O. P. Gupta.  
International Journal of Tropical Agriculture IJTADD, Vol. 7, No. 1/2, p 56-64, March/June 1989. 2 fig, 4 tab, 16 ref.

Descriptors: \*Crop yield, \*India, \*Irrigation practices, \*Legumes, \*Phosphorus, Climates, Irrigation requirements, Plant growth, Plant nutrients, Plant water potential, Water stress, Water use efficiency.

Two years of field research showed that in pigeonpea, branching and flowering stages were critical for moisture stress. Application of water, through irrigation, at these two crop stages, gave average pulse yields of 22.03 q/ha and resulted in water use efficiency (WUE) of 5.55 kg/mm/ha. Irrigation applied at other crop stages gave significantly less pulse yield and WUE. Scheduling irrigation by climatological approach showed that cumulative pan evaporation (CPE) of 125 mm was equivalent to two irrigation periods, at branching and flowering stages, for pulse yield and WUE. But at this CPE, three to four applications of irrigation water had to be applied. More frequent irrigation did not increase pigeonpea yield. Pigeonpea responded significantly to the application of phosphorus (up to 60 kg orthophosphate/ha) with pulse yield increased of 2.84 q/ha and WUE by 9.9% over the control. (Author's abstract) W91-01116

**EFFECTS OF IRRIGATION METHODS ON GROWTH, YIELD AND CONSUMPTIVE USE OF WATER OF BANANA CV. NENDRAN GROWN IN CLAY LOAM SOILS.**  
Regional Agricultural Research Station, Kasaragod (India).  
A. Rajagopalan, K. Sudhakara, R. Ravegnandran Nair, and G. S. L. H. V. Prasada Rao.  
International Journal of Tropical Agriculture IJTADD, Vol. 7, No. 1/2, p 111-117, March/June 1989. 1 fig, 5 tab, 6 ref.

Descriptors: \*Banana, \*Consumptive use, \*Irrigation effects, \*Irrigation practices, \*Plant growth, Basin irrigation, Drip irrigation, India, Irrigation requirements, Plant physiology, Plant water potential, Soil types, Soil water, Subsurface irrigation.

Banana growers in the Kerala region of India cultivate the crop under rainfed conditions where soil moisture stress is severe during the bunch emergence stage. The conventional method of basin irrigation at different frequencies, drip irrigation and subsoil injection of water were studied on Nendran bananas grown in clay loam soils. Basin irrigation at 20 mm on alternate days was superior to drip irrigation and subsoil injection for growth and yield of bananas. For water use efficiency, 5 mm water, via subsoil injection, on alternate days and 2.5 mm water, via drip irrigation, on every day were the most efficient methods. Frequent basin irrigations with 40 L water favor the growth and yield of the Nendran banana. In areas where irrigation water is available in plenty and labor is cheap, irrigation every two days is recommended. In places where irrigation water is available, but labor charges are high, irrigation with 40 L water every five to six days is recommended. In places where both water and labor are scarce, drip irrigation should be practiced. (Brunone-PTT) W91-01117

**MIXING IN OVERLAND FLOW DURING RAINFALL.**  
Missouri Univ.-Columbia. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5B. W91-01153

**AGRICULTURE: A POSITIVE CONTRIBUTION TO WATER QUALITY.**  
Imperial Chemical Industries Ltd., Billingham (England).

For primary bibliographic entry see Field 5G. W91-01249

**EFFECT OF ROCK BUNDS AND TIED RIDGES ON SOIL WATER CONTENT AND SOIL PROPERTIES IN THE SUDAN SAVANNAH OF BURKINA FASO.**

Semi-Arid Food Grain Research and Development Office, Ouagadougou (Burkina Faso). N. R. Hulugalle, J. de Koning, and P. J. Matlon. Tropical Agriculture TAGLA2, Vol. 67, No. 2, April 1990. 2 fig, 3 tab, 20 ref.

Descriptors: \*Agricultural hydrology, \*Cultivated lands, \*Soil water, \*West Africa, Agricultural runoff, Clays, Crop production, Cultivation, Organic matter, Particle size, Rock bunds, Sand, Silt, Sorghum, Tied ridges.

A trial was conducted during the growing seasons of 1985 and 1986 in the Sudan Savannah of Burkina Faso, West Africa, to evaluate the effect of rock bunds and tied ridges constructed by donkey-traction on soil water content and soil properties. Soil water content was measured by gravimetric sampling at 7 to 10-day intervals during the season. Soil sampled from 0-0.05 m depth at the termination of the trial was analyzed for particle size distribution, organic matter content and soil water retention. Rock bunds increased soil water content in the surface 0.30 m immediately above a rock line by an average of 32% in both 1985 and 1986. Away from the rock lines, bunds had no effect whereas tied ridges increased soil water content. At 2 m below a rock line, soil water content was increased by an average of 23% in 1985 and 19% in 1986 and midway between two rocklines by an average of 11% in 1985 and 18% in 1986. Both rock bunds and tied ridges improved water conservation in the short-term, with the tied ridges being more efficient. Soil water retention and clay content in the surface 0.05 m were, however, greater with rock bunds and greatest when tied ridges and rock bunds were combined. Sand, silt and soil organic matter were not affected by either rock bunds or tied ridges. Sorghum grain yield was increased only by tied ridges, and was due primarily to increases in soil water content during flowering. Yield was greatest, however, when tied ridges were combined with rock bunds. It was concluded that tied ridges were more efficient than rock bunds in increasing soil water content during the growing season. Rock bunds were, however, more efficient in reducing loss of clay particles in surface runoff. (Author's abstract) W91-01330

**COMPUTERIZED SCHEDULING FOR IRRIGATION MANAGEMENT AND PUMPING OPERATIONS IN THE WATERCOURSE COMMAND.**

National Agricultural Research Centre, Islamabad (Pakistan). S. Ahmad, and D. F. Heermann. Agricultural Water Management AWMADF, Vol. 18, No. 1, p 1-13, May 1990. 1 fig, 3 tab, 13 ref.

Descriptors: \*Computerized irrigation scheduling, \*Irrigation, \*Irrigation efficiency, \*Irrigation scheduling, \*Model studies, \*Pakistan, Agricultural hydrology, Demand irrigation, Farming, Fixed-rotation irrigation, Simulation.

A model to simulate the irrigation schedules of a watercourse command was developed to predict cropping intensity, net farm return, farm water use, percent water utilized, deep percolation at farm level, rainfall contribution, and extra tubewell water pumped. Schedules for three selected farms on a watercourse command in Sargodha, Pakistan were simulated with three fixed-rotation strategies and compared to a demand strategy. The fixed-rotation strategies were also compared for evaluation of the allowable depletion criteria. Evaluation of simulation (1973-1982) showed that the three fixed-rotation systems reduced the net farm return by 28-43% from that of a demand strategy. The fixed-rotation system also had 17-39% in water pumpage and energy consumed will be reached in a fixed-rotation system. The change of the fixed-rotation system to a demand system will significantly

increase the net farm return in addition to improved water allocation to various farms on a watercourse command. The demand strategy will provide savings in energy due to scheduled pumping operations and effective utilization of canal water supplies. (Author's abstract) W91-01404

**ADOPTING WATER-CONSERVING IRRIGATION TECHNOLOGY: THE CASE OF SURGE IRRIGATION IN ARIZONA.**

Idaho Univ., Moscow. Dept. of Agricultural Economics. R. H. Coupal, and P. N. Wilson. Agricultural Water Management AWMADF, Vol. 18, No. 1, p 15-28, May 1990. 3 tab, 24 ref, append.

Descriptors: \*Arid lands, \*Arizona, \*Cost analysis, \*Furrow irrigation, \*Irrigation, \*Irrigation efficiency, \*Surge irrigation, Agricultural water, Deserts, Farming.

Surge-flow irrigation technology is a potential means for increasing irrigation efficiencies in desert agriculture. An economic analysis of the adoption decision for Arizona farmers reveals that an investment in surge irrigation is only economically viable when developing new agriculture lands or where gated pipe is already in use. Since the majority of the agricultural land in Arizona is furrow irrigated using ditches and syphon tubes, the potential for high adoption rates on existing farmland is rather limited. The analysis indicates that water costs, under conservative but realistic assumptions, would have to rise to \$0.08/cubic m (\$100/acre foot) before surge irrigation would be economically viable as a substitute for open ditch furrow irrigation. Further research is needed on potential labor savings and management efficiencies related to surge irrigation in order to measure potential profitability more accurately. (Author's abstract) W91-01405

**ESTIMATION OF MANNING'S ROUGHNESS COEFFICIENT FOR BASIN AND BORDER IRRIGATION.**

Bangladesh Agricultural Research Inst., Joydebpur. M. Harun-ur-Rashid. Agricultural Water Management AWMADF, Vol. 18, No. 1, p 29-33, May 1990. 1 tab, 5 ref.

Descriptors: \*Bangladesh, \*Irrigation, \*Mannings equation, \*Roughness coefficient, \*Surface irrigation, Agricultural hydrology, Data interpretation, Volume balance analysis, Water potentials.

Selection of a specific surface roughness value in a particular field situation in surface irrigation is not well established. Therefore a technique for determination of surface roughness values for basin and border irrigation from irrigation field data was developed. Volume balance analysis, a partial differential form of the continuity equation, and Manning's equation for open channel flow were used as governing equations. The forward difference approximation of the finite difference method was used as the solution technique. Flow resistance (Manning's  $n$ ) is one of the important factors which govern the flow in irrigation basins and borders. Accuracy of results by the present technique depends on the accuracy of input data, particularly the surface water depth data. The accuracy of surface water depth data is again dependent on the levelness of the field and the efficiency, experience and visual judgment of the observer. If a good set of irrigation field data is available, a reasonable result can be obtained from the analysis of this technique. Field data collected from the central farm of Bangladesh Agricultural Research Institute at Joydebpur was used to test the technique. Roughness values derived by this technique were compared with those reported by several investigators. A reasonably good agreement was found between the predicted and reported roughness values. (Mertz-PTT) W91-01406

**CANOPY TEMPERATURE AS AN INDICATOR OF DIFFERENTIAL WATER USE AND YIELD**

**PERFORMANCE AMONG WHEAT CULTIVARS.**

Agricultural Research Service, Phoenix, AZ. Water Conservation Lab. P. J. Pinter, G. Zipoli, R. J. Reginato, R. D. Jackson, and S. B. Idso. Agricultural Water Management AWMADF, Vol. 18, No. 1, p 35-48, May 1990. 10 fig, 1 tab, 26 ref.

Descriptors: \*Canopy, \*Crop yield, \*Plant growth, \*Temperature effects, \*Water potentials, \*Wheat, Agricultural hydrology, Arid lands, Arizona, Farming, Irrigation, Soil water.

Field experiments were conducted at Phoenix, Arizona to investigate the usefulness of canopy temperatures in screening wheat genotypes for water use and yield characteristics. Six spring wheat (*Triticum aestivum* L.) cultivars were grown under well-watered conditions and two deficit irrigation regimes. Canopy temperatures were measured daily at 1045 hours, 1345 hours and 1545 hours using hand-held infrared thermometers. Leaf stomatal conductances were obtained between 1245 and 1400 hours. Seasonal water use was estimated via a soil water budget approach. There were small but consistent differences in canopy temperatures among cultivars in the well-watered treatments. Yecora, the warmest cultivar, had a mean midday canopy temperature of 25.1°C over the growth period from stem elongation until the hard dough stage of growth; Siete cerros, the coolest, was 23.3°C. Canopy temperatures values were lower earlier and later in the day but all cultivars maintained the same ranking relative to each other. Cultivars with higher midday canopy temperatures under well-watered conditions used less water and had lower stomatal conductances than those with cooler temperatures. Grain yields for all cultivars were similar under well-watered conditions but varied considerably under water stress. Cultivars that were warmest when well-watered maintained the highest relative yields when exposed to deficit irrigation regimes. Results indicate that routine canopy temperature comparisons between new cultivars and genotypes having well-known water use and yield characteristics will provide additional selection criteria for maximizing performance under water stress conditions. (Author's abstract) W91-01407

**WATER AND FERTILIZER INTERRELATIONS WITH IRRIGATED MAIZE.**

Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Agricultural Engineering. H. O. Fapohunda, and M. M. Hossain. Agricultural Water Management AWMADF, Vol. 18, No. 1, p 49-61, May 1990. 6 fig, 4 tab, 12 ref.

Descriptors: \*Corn, \*Crop yield, \*Fertilization, \*Irrigation, \*Nigeria, \*Sprinkler irrigation, Crop production, Maize, Soil water, Water potentials, Water requirements.

Maize yield interactions with water and fertilizer using a line source sprinkler system were examined. Field studies were conducted at the Teaching and Research Farm of the Obafemi Awolowo University, Ile-Ife, Nigeria between December, 1984 and February, 1986 on a silty loam soil classified as an Alfisol. The experiment was conducted twice for two seasons. Maize yields as related to water applied and fertilizer used were determined using a line source sprinkler system. The line source irrigation system used impact sprinklers at 6.1 m intervals along the lateral. The average discharge per sprinkler was 0.51 L/second with a wetting diameter of 30 m. Generally, maize yields increased with increasing water and fertilizer applications. The maximum grain yield of 6.15 ton/hectare was produced with 523 mm of water and 300 kg/hectare of NPK (15-15-15) fertilizer, while the highest dry matter yield of 17.84 ton/hectare occurred with 495 mm of water and 300 kg/hectare of NPK fertilizer. Maize yields were highly correlated with water and fertilizer. A highly significant water x fertilizer interaction (at 1% level) indicated high maize yields when fertilizer uptake is enhanced by high soil moisture level. Water productivity was increased by fertilizer application, but the relationship was not as definite with soil moisture. Produc-

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tion functions were generated to reliably predict maize yields. (Mertz-PTT)  
W91-01408

#### DYNAMICS OF ROOT AND SHOOT GROWTH OF BARLEY UNDER VARIOUS LEVELS OF SALINITY AND WATER STRESS.

Agriculture and Water Resources Research Centre, Baghdad (Iraq). Dept. of Soil and Land Reclamation.  
S. Al-Khafaf, A. Adnan, and N. M. Al-Asadi.  
Agricultural Water Management AWMADP, Vol. 18, No. 1, p 63-75, May 1990. 9 fig, 4 tab, 22 ref.

Descriptors: \*Barley, \*Crop yield, \*Evapotranspiration, \*Irrigation, \*Plant water potential, \*Saline soils, \*Water stress, Dry weight, Growth, Roots, Salinity, Soil water.

Response of barley to water stress at different growth stages at various levels of soil salinity was studied in cylindrical wooden containers (1.1 m long and 0.6 m in diameter). The treatments consisted of three salinity levels and two irrigation treatments; no water stress at any given growth stage, and plants exposed to water stress at either tillering, vegetative, flowering or seed formation stage and normally irrigated in the other stages. Comparison in above-ground dry weights indicated a significant variation between different treatments at each sampling date. The interaction between salinity and water stress was also significant. Maximum reduction in shoot dry weight was 70% under high salinity treatment when the plants were exposed to water stress in the vegetative growth stage. The relative reductions in shoot dry weights due to salinity at the vegetative growth stage were 33% for medium salinity and 46% for high salinity, in comparison with low salinity treatment. Root dry weights significantly varied between different treatments. The highest reduction in root dry weights was recorded when the plants were exposed to water stress and/or salinity at the vegetative growth stage. Linear relations between evapotranspiration and above-ground dry weights, grain yields and root dry weights were obtained. Regardless of water stress or salinity levels, barley grain, above ground dry weights, and root dry weights were correlated with evapotranspiration. (Author's abstract)  
W91-01409

#### SUSTAINABLE RATES OF SEWAGE SLUDGE FOR DRYLAND WINTER WHEAT PRODUCTION: I. SOIL NITROGEN AND HEAVY METALS.

Colorado State Univ., Fort Collins. Dept. of Agronomy.  
For primary bibliographic entry see Field 5E.  
W91-01503

#### SUSTAINABLE RATES OF SEWAGE SLUDGE FOR DRYLAND WINTER WHEAT PRODUCTION: II. PRODUCTION AND INCOME.

Colorado State Univ., Fort Collins. Dept. of Agronomy.  
For primary bibliographic entry see Field 5E.  
W91-01504

#### CHANGES IN WEST AFRICAN SAVANNA AGRICULTURE IN RESPONSE TO GROWING POPULATION AND CONTINUING LOW RAINFALL.

International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).  
For primary bibliographic entry see Field 6D.  
W91-01683

#### HEAT STRESS, PLANT-AVAILABLE SOIL MOISTURE, AND CORN YIELDS IN IOWA: A SHORT- AND LONG-TERM VIEW.

Iowa State Univ., Ames. Dept. of Agronomy.  
R. E. Carlson.  
Journal of Production Agriculture, Vol. 3, No. 3, p 293-297, July/September 1990. 6 fig, 2 tab, 19 ref.

Descriptors: \*Available water, \*Corn, \*Crop yield, \*Iowa, \*Soil-water-plant relationships,

\*Thermal stress, History, Model studies, Regression analysis, Soil water, Stress, Temperature, Weather.

A study was conducted to identify weather factors that significantly affect corn production in Iowa from available long-term weather records. Regression analysis identified heat stress and plant available soil moisture as the two most important weather-related variables affecting corn yields in central Iowa. Heat stress was defined as the monthly or seasonal accumulation of the number of degrees each day when maximum temperatures exceeded 86 F (30 C). The regression model used included terms representing technology (time), heat stress in July and August, 1 July plant-available soil moisture in the top five feet of soil, and an interaction term between the last two variables. The model accounted for 90% of the variation in corn yield between 1954 and 1988. Time trends accounted for 62% of the yield variation, and weather factors for 28%. When July 1 plant available soil moisture was below normal (approximately 7 in), heat stress in July and August caused greater yield reductions than when plant available soil moisture was above normal. To compare the present climate with previous years, a seasonal heat stress variable was computed for 1900-1988. This revealed periods of both benign (1958-1975) and hostile (1900-1957) characteristics relative to expected and realized corn yields. Runs of stressful days each season showed similar patterns of season to season variability. The 1 July plant available moisture trends for central Iowa clearly show that the benign period mentioned was also one of adequate levels of crop growing season soil moisture. This work identifies two variables (heat stress and 1 July plant-available soil moisture) that, over a long period of time, reveal considerable inter-annual variability. The late 1950's, the 1960's, and the early 1970's were very favorable for corn production in central Iowa, as well as in other parts of the midwest. This data reveals this to be an unusual and benign time period when compared to other time periods of this century. The ups and downs of the 1980's may be closer to current expected weather. (Lantz-PTT)  
W91-01703

#### USE OF LIME-STABILIZED DAIRY-PLANT WASTE FOR FORAGE PRODUCTION.

Missouri Univ.-Columbia. Dept. of Agronomy.  
For primary bibliographic entry see Field 5E.  
W91-01704

#### CROPPING SYSTEM AND TILLAGE EFFECTS ON AVAILABLE SOIL WATER AND YIELD OF GRAIN SORGHUM AND WINTER WHEAT.

Southwest Kansas Research-Extension Center, Garden City.  
C. A. Norwood, A. J. Schlegel, D. W. Morishita, and R. E. Gwin.  
Journal of Production Agriculture, Vol. 3, No. 3, p 356-362, July/September 1990. 8 tab, 11 ref.

Descriptors: \*Crop yield, \*Soil-water-plant relationships, \*Sorghum, \*Tillage, \*Wheat, Available water, Comparison studies, Garden City, Kansas, Productivity, Soil water, Tribune, Water conservation.

Wheat (*Triticum aestivum* L.), in the central or southern Great Plains, is grown in a 2 yr wheat-fallow (WF) cropping system or with grain sorghum (*Sorghum bicolor* (L.) Moench) in a 3 yr wheat-sorghum-fallow (WSF) system. Tillage during fallow causes loss of crop residue and soil water. Long-term studies were conducted at Garden City and Tribune, KS, to determine the effects of cropping system and reduced tillage on available soil water and yield of dryland winter wheat and grain sorghum. Conventional (CT), reduced (RT), minimum (MT), and no-tillage (NT) systems were compared with CT in sorghum-fallow (SF), continuous sorghum (SS), and continuous wheat (WW). Reductions in tillage resulted in increased available soil water and yield. Reduced tillage resulted in increased WF yields at both locations, while WSF wheat yields were increased at Tribune. Sorghum yields were more consistently increased by reduced tillage at Tribune. Sorghum

fallow yields were higher than WSF sorghum yields at Tribune. Wheat-fallow yields usually did not differ from WSF yields at either location. Sorghum yields in WSF exceeded SS yields 67% of the time at Garden City. At Tribune WSF-RT yields exceeded SS yields 73% of the time, while WSF-CT yields were no better or less than SS yields 60% of the time. Continuous wheat yields were less than other wheat yields 98% of the time. In terms of soil water storage and yield, the WSF system is appropriate for both locations, and is more effective when combined with reduced tillage, particularly at Tribune. (Author's abstract)  
W91-01705

#### STRENGTH OF SCLEROPHYLLOUS CELLS TO RESIST COLLAPSE DUE TO NEGATIVE TURGOR PRESSURE.

Eidgenossische Technische Hochschule, Zurich (Switzerland). Inst. of Plant Sciences.  
For primary bibliographic entry see Field 2I.  
W91-01800

#### DEVELOPMENT OF METHODOLOGY AND CRITERIA FOR IRRIGATION MANAGEMENT UNDER LIMITED WATER CONDITIONS.

Nebraska Univ.-Lincoln. Dept. of Agricultural Economics.

R. J. Supalla, and D. L. Martin.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-222308/AS. Price codes: A04 in microfiche, A01 in paper copy. Final Report, April 20, 1990. 68p, 24 fig, 9 tab, append. USGS Contract no. 14-08-0001-G1141.

Descriptors: \*Groundwater, \*Irrigation scheduling, \*Management planning, \*Nebraska, \*Optimum development plans, \*Water conservation, Dynamic programming, Irrigation systems, Model studies, Regulations, Water allocation.

How to optimally manage irrigation systems under water limiting groundwater regulations is an increasingly common question in the Western United States. Methodologies for addressing this question were developed and applied to a Nebraska case study region. Dynamic programming was used to analyze both inter-seasonal planning decisions and intra-seasonal irrigation scheduling decisions. The optimum plan for Central Nebraska under groundwater limitations was generally to produce continuous corn at less than full irrigation. For some water limiting conditions a permanent or short term disinvestment in irrigation systems was found to be profitable and small acreages of alternative crops emerged as appropriate in a few instances. Optimum intra-seasonal irrigation scheduling involved establishing a target marginal net return based on the planning model and then applying water to meet the target, with consideration of actual weather and the plant response in each growth stage. (USGS)  
W91-01853

## 4. WATER QUANTITY MANAGEMENT AND CONTROL

### 4A. Control Of Water On The Surface

#### REVISED RUNOFF BLOCK OF SWMM.

Colorado Univ. at Denver. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 4C.  
W91-01190

#### SWMM-4.

Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.  
For primary bibliographic entry see Field 4C.  
W91-01191

## Groundwater Management—Group 4B

**REAL-TIME MULTIPURPOSE RESERVOIR OPERATION: A CASE STUDY.**

Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.  
S. Vedula, and S. Mohan.  
Hydrological Sciences Journal HSJODN, Vol. 35, No. 4, p 447-462, August 1990. 4 fig, 5 tab, 21 ref.

Descriptors: \*India, \*Multipurpose reservoirs, \*Regression analysis, \*Reservoir operation, \*Water resources development, Case studies, Computer models, Developing countries, Hydroelectric power, Irrigation, Model testing, Simulation analysis, Streamflow, Streamflow forecasting, Water resources management.

Optimum development of water resources for irrigation and hydropower generation is a high priority consideration in the economic development of most developing countries, as food and energy continue to be among the most pressing needs. A real-time operational methodology was developed for a multipurpose reservoir operation for the generation of hydroelectric power irrigation water, which was applied to the Bhadra reservoir system in the state of Karnataka, India. The method consists of three phases of computer modeling. In the first phase, the optimal release policy for a given initial storage and inflow is determined using a stochastic dynamic programming model. Streamflow forecasting using an adaptive Autoregressive Integrated Moving Average model constitutes the second phase. A real-time simulation model is developed in the third phase which uses the forecast inflows from the second phase and the operating policy from the first phase. A comparison of the optimal monthly real-time operation with the historical operation demonstrates the relevance, applicability and relative advantages of the proposed methodology. (Author's abstract)  
W91-01464

**SIMPLIFIED ANALYSIS OF SOIL WATER FLOW TO A MOLE DRAIN.**

Massey Univ., Palmerston North (New Zealand). Dept. of Soil Science.  
For primary bibliographic entry see Field 2G.  
W91-01476

**DOWNSTREAM OF THE NOVOSIBIRSK HYDROELECTRIC STATION ON THE OB RIVER.**

V. P. Bityukov.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 10, p 587-591, April 1990. 1 fig. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 25-28, October 1989.

Descriptors: \*Channel erosion, \*Dams, \*Hydroelectric plants, \*Hydrologic regime, \*Metropolitan water management, \*Soviet Union, \*Water resources management, Channel improvement, Channel stability, Reservoirs, Water level fluctuations, Watershed management.

The construction of large hydroelectric developments on flatland rivers introduces large changes in their natural hydrologic regime. The 30-year period of operation of the Novosibirsk (Soviet Union) hydro development on the Ob River clearly confirms the indicated relation between fluvial processes in the river and operation of water-management objects of the city. The natural process of deep channel erosion diminished after damming the river and creation of the reservoir during the first decade of operation. In the second half of the 1960s, quarrying in the lower pool adjacent to the hydrostation began to have a substantial effect on the natural transformation process of the channel due to streamflow regulation and retention of sediments by the reservoir. During the period between 1966 and 1984 more than 40 million cu m of sand-gravel mixture was dredged from the river channel and floodplain, causing a decrease in water levels. A decrease in levels downstream led to a deficit of reservoir water resources in dry years. The priority of water users of Novosibirsk is partial restoration of the water levels in the stretch between the hydrostation and the city by constructing embankments damming nonnavigable branches and converting the channel into a single-branch channel. A radical solution for the problem

of reliably providing water to consumers in the city is to reconstruct all intakes located downstream of the hydro development. (Fish-PTT)  
W91-01544

**EVALUATION OF DETENTION BASIN PERFORMANCE IN THE PIEDMONT REGION OF NORTH CAROLINA.**

North Carolina Univ. at Charlotte. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5G.  
W91-01824

**FLOOD OF OCTOBER 1983 AND HISTORY OF FLOODING ALONG THE SAN FRANCISCO RIVER, CLIFTON, ARIZONA.**

Geological Survey, Tucson, AZ. Water Resources Div.  
For primary bibliographic entry see Field 2E.  
W91-01849

**4B. Groundwater Management****GROUNDWATER: A REVIEW OF THE 1989 LITERATURE.**

North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.  
For primary bibliographic entry see Field 2F.  
W91-01178

**DEEP-WELL IN THE NORTH-HOLLAND DUNE AREA.**

Waterworks of North-Holland, Bloemendaal (Netherlands).  
E. Roomsma, and A. Stakelbeek.  
Ground Water GRWAAP, Vol. 28, No. 5, p 778-782, September/October 1990. 10 fig, 8 ref.

Descriptors: \*Artificial recharge, \*Deep wells, \*Groundwater management, \*Infiltration, \*The Netherlands, \*Water resources development, \*Water resources management, \*Water supply, Drinking water, Ecological effects, Potable water, Public policy, Water quality.

The government's policy concerning the management of the dunes in The Netherlands on behalf of the interests of nature and the environment is causing constraints for the waterworks of North-Holland located in the dunes at the North Sea coast. The existing artificial recharge systems consist mostly of ponds and open canals in which imported pretreated surface water is infiltrated to provide a reliable drinking water supply in the province of North-Holland. Because the quality of the water, infiltrated by canals has a negative influence on ecological values, extension of this system will not be possible. An alternative is deep-well infiltration; instead of infiltrating by canals, water will be infiltrated in semiconfined aquifers, so there will be less influence on existing ecological values. The Provincial Waterworks of North-Holland are constructing a pilot plant with a capacity of 5 million cubic meters/acre/year to investigate its reliability and its suitability for a development as natural as possible for this region. The history of artificial recharge is presented along with an overall look at the preliminary investigations, and an overview of the main issues for a definite engineering. (Author's abstract)  
W91-01304

**BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 1. EXPERIMENTAL INVESTIGATION.**

Princeton Univ., NJ. Dept. of Computer Science.  
For primary bibliographic entry see Field 2F.  
W91-01531

**BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 2. PERMEABILITY.**

Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.  
For primary bibliographic entry see Field 2F.

W91-01532

**BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 3. DISPERSIVITY AND MODEL VERIFICATION.**

Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.  
For primary bibliographic entry see Field 2F.  
W91-01533

**OPTIMAL ARTIFICIAL RECHARGE IN INTERMITTENT MULTIBASIN SYSTEM.**

K.N. Toossi Univ. of Technology, Tehran (Iran). Dept. of Civil Engineering.  
K. Zomorodi.  
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 639-651, September/October 1990. 7 fig, 23 ref.

Descriptors: \*Artificial recharge, \*Flow equations, \*Recharge basins, \*Sedimentation, \*Water resources management, Computer models, Constant flow, Flow rates, Infiltration rate, Suspended sediments.

Among the various factors that reduce the rate of recharge in an artificial recharge basin with time, the settling of the suspended sediments in the recharge water is usually the most important. An equation has been developed to represent the change of infiltration rate of a turbid water with time and with the concentration of suspended sediments. This equation was further generalized to consider the effect of the basin size on the recharge rate. Optimal scheduling of consecutive recharge and dry periods was determined to result in the maximum recharge rate in the long run. A computer model was developed to provide the optimal design of an intermittent multibasin recharge (IMBR) system. The model was run using a set of real field data, and the results show that when a constant flow rate is available during the recharge season, IMBR would be a more efficient system of artificial recharge than either continuous or intermittent recharge on a single basin. (Author's abstract)  
W91-01554

**RECONNAISSANCE-LEVEL ALTERNATIVE OPTIMAL GROUND-WATER USE STRATEGIES.**

Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering.  
For primary bibliographic entry see Field 6D.  
W91-01557

**CALIFORNIAIZATION OF ARIZONA WATER POLITICS.**

For primary bibliographic entry see Field 6B.  
W91-01631

**PREDICTING WELL DRAWDOWN DURING PROLONGED PUMPING.**

Westinghouse Environmental and Geotechnical Services, Cary, NC.  
D. L. Goodrich.  
Water Well Journal WWJOA9, Vol. 44, No. 8, p 32-33, August 1990. 2 fig.

Descriptors: \*Groundwater movement, \*Wells, Confined aquifers, Unconfined aquifers, \*Aquifers, \*Drawdown, \*Pumping test, Water supply, Data interpretation.

An important consideration in groundwater management is whether prolonged pumping will result in dewatering of the aquifer. The first step in extrapolating the drawdown data beyond the end of a constant-rate pumping test is to plot the data from the test on semilogarithmic graph paper. The drawdown data from the test of an unconfined aquifer is usually corrected for locally diminished transmissivity and plotted above the field data. The trend of the actual artesian drawdown may be projected in a straight line to predict the drawdown after several months of continuous pumping.

## Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4B—Groundwater Management

To simulate a maximum drawdown, the slope of the projected trend can be steepened to double that of the observed data. If the cone of depression is small in relation to the size of the aquifer, the drawdown will stabilize in less than 70 days in most situations. This procedure can be useful in predicting long-term drawdown when pumping a water supply well during periods of drought. (Miller-PTT)  
W91-01682

**MODELING ORGANIC CONTAMINANT SORPTION IMPACTS ON AQUIFER RESTORATION.**  
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.  
For primary bibliographic entry see Field 5B.  
W91-01827

**GROUND-WATER RESOURCES OF THE ARKANSAS RIVER BASIN IN ARKANSAS.**  
Geological Survey, Little Rock, AR. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01835

**WATER-RESOURCES DATA-NETWORK EVALUATION FOR MONTEREY COUNTY, CALIFORNIA, PHASE 3: NORTHERN SALINAS RIVER DRAINAGE BASIN.**  
Geological Survey, Sacramento, CA. Water Resources Div.  
For primary bibliographic entry see Field 7A.  
W91-01836

**ASSESSMENT OF HYDROLOGIC AND HYDROGEOLOGIC DATA AT CAMP LEJEUNE MARINE CORPS BASE, NORTH CAROLINA.**  
Geological Survey, Raleigh, NC. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01840

**HYDROGEOLOGY OF AQUIFERS IN CRETACEOUS AND YOUNGER ROCKS IN THE VICINITY OF ONSLOW AND SOUTHERN JONES COUNTIES, NORTH CAROLINA.**  
Geological Survey, Raleigh, NC. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01841

**WATER RESOURCES OF CODINGTON AND GRANT COUNTIES, SOUTH DAKOTA.**  
Geological Survey, Huron, SD. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01842

**HYDROLOGY OF THE POWDER RIVER ALLUVIUM BETWEEN SUSSEX, WYOMING, AND MOORHEAD, MONTANA.**  
Geological Survey, Cheyenne, WY. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01852

**DEVELOPMENT OF METHODOLOGY AND CRITERIA FOR IRRIGATION MANAGEMENT UNDER LIMITED WATER CONDITIONS.**  
Nebraska Univ.-Lincoln. Dept. of Agricultural Economics.  
For primary bibliographic entry see Field 3F.  
W91-01853

#### 4C. Effects On Water Of Man's Non-Water Activities

**NUTRIENT EXPORT IN STORMFLOW FOLLOWING FOREST HARVESTING AND SITE-REPREPARATION IN EAST TEXAS.**  
Agricultural Research Service, Boise, ID. North-

west Watershed Research Center.  
For primary bibliographic entry see Field 5B.  
W91-01009

**ASSESSMENT OF CUMULATIVE IMPACTS TO WATER QUALITY IN A FORESTED WETLAND LANDSCAPE.**  
Clemson Univ., Georgetown, SC. Belle W. Baruch Forest Science Inst.  
D. L. Childers, and J. G. Gosselink.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 455-464, July/September 1990. 5 fig, 3 tab, 38 ref.

Descriptors: \*Ecological effects, \*Environmental impact, \*Forest ecosystems, \*Forest watersheds, \*Land use, \*Water pollution effects, \*Wetlands, Agriculture, Louisiana, Management planning, Nitrogen, Phosphorous, Streams, Suspended sediments, Tensas Basin, Turbidity, Water quality management, Water quality monitoring, Watershed management.

In a procedure for determining cumulative impacts in bottomland hardwood forests (BLHF), changes in landscape integrity over time were assessed using structural and functional ecosystem indices. Historical records of suspended sediment, N, P, and turbidity from three streams in the Tensas Basin, Louisiana were analyzed. Significant positive relationships between water levels in these streams and concentrations of total P, total Kjeldahl N, total suspended sediment and turbidity confirmed a loading phenomenon characteristic of watersheds in which much of the original forest cover has been cleared. Eighty-five percent of the original forest in the Tensas Basin has been converted to agricultural fields. N/P ratios in two of the rivers (6.4:1 and 10.2:1 molar ratios) were lower than expected in P-limited freshwater systems, where N/P ratios are generally >10:1. Most of the excess in P is probably related to the geochemical adsorption of P to sediment particles and selective loading of P during erosive storm events. As a result, the nutrient limiting aquatic primary productivity may be N in much of the Tensas Basin. Between 1978 and 1986, P levels exceeded 0.1 mg/L 96% of the time (P > 0.1 mg/L signals eutrophy in lotic systems). Total suspended sediment concentration patterns were erratic and in excess of 80 mg/L over half of the time in two of the three streams studied (1966-1986). A goal oriented management plan for improved water quality in the Tensas Basin was devised based on this cumulative impact assessment. Improvement of the ecosystem can be achieved in a number of ways, including the reestablishment of natural hydrologic flow wherever possible, the use of agricultural practices that reduce runoff, the protection of existing forested corridors along streams, and the mitigative creation of new buffering zones. (Author's abstract)  
W91-01017

**EFFECTS OF CLEARFELLING A SITKA SPRUCE STAND ON THE WATER BALANCE OF A PEATY GLEY SOIL AT KERSHOPE FOREST, CUMBRIA.**  
Forestry Commission, Midlothian (Scotland). Northern Research Station.  
A. R. Anderson, D. G. Pyatt, and J. P. Stannard.  
Forestry, Vol. 63, No. 1, p 52-71, 1990. 3 fig, 9 tab, 26 ref, 1 append.

Descriptors: \*Clear-cutting, \*Forest watersheds, \*Hydrologic budget, \*Kershope Forest, \*Soil water, \*Spruce trees, Environmental effects, Evapotranspiration, Forestry, Land use, Precipitation, Rainfall-runoff relationships, Scotland.

From 1981-1985 the water balance of four 2 ha plots of a ploughed and drained Sitka spruce plantation was monitored. During 1983, three plots were clearfelled and a fourth was left standing as a control. A ground level rain gage over-collected during snow, but otherwise collected 3% more water than standard rain gages. Annual precipitation (1259-1688 mm) averaged 1439 mm. The forest canopy intercepted 38% and transpired 12% of gross precipitation. Fifty percent of gross precipitation was evaporated while 50% left the site as

runoff. Throughfall and stemflow fractions of net precipitation were 0.87 and 0.13 respectively. After clearfelling, annual runoff increased to 68% of gross precipitation. After adjustment using the before and after comparison in the control plot, the decrease in annual evaporative loss resulting from clearfelling was 290 mm. (Author's abstract)  
W91-01069

**HUMUS FORM DEVELOPMENT AND HILLSLOPE RUNOFF, AND THE EFFECT OF FIRE AND MANAGEMENT, UNDER MEDITERRANEAN FOREST IN NE-SPAIN.**  
Amsterdam Univ. (Netherlands). Lab. for Physical Geography and Soil Science.  
For primary bibliographic entry see Field 2G.  
W91-01079

**UNEXPECTED HYDROLOGIC PERTURBATION IN AN ABANDONED UNDERGROUND COAL MINE: RESPONSE TO SURFACE RECLAMATION.**  
Indiana Geological Survey, Bloomington.  
D. Harper, G. A. Olyphant, and E. J. Hartke.  
Environmental Geology and Water Sciences EGWSEL, Vol. 15, No. 3, p 179-187, May/June 1990. 5 fig, 2 tab, 12 ref.

Descriptors: \*Coal mines, \*Land reclamation, \*Mine wastes, \*Subsidence, Disturbance, Flooding, Geologic fractures, Potentiometric level.

A reclamation project at the abandoned Blackhawk Mine site near Terre Haute, Indiana, lasted about four months and involved the burial of coarse mine refuse in shallow (less than 9 m) pits excavated into loess and till in an area of about 16 ha. An abandoned flooded underground coal mine underlies the reclamation site at a depth of about 38 m; the total area underlain by the mine is about 10 sq km. The potentiometric levels associated with the mine indicate a significant (2.7 m) and prolonged perturbation of the deeper confined groundwater system; 14 months after completing reclamation, the levels began to rise linearly (at an average rate of 0.85 cm/day) for 11 months, then fell exponentially for 25 months, and are now stable. Prominent subsidence features exist near the reclamation site. Subsidence-related fractures were observed in cores from the site, and such fractures may have provided a connection between the shallower and deeper groundwater systems. (Author's abstract)  
W91-01098

**DIRECT IMPACTS OF OUTER CONTINENTAL SHELF ACTIVITIES ON WETLAND LOSS IN THE CENTRAL GULF OF MEXICO.**  
Louisiana State Univ., Baton Rouge. Center for Energy Studies.  
For primary bibliographic entry see Field 2L.  
W91-01099

**PROCEEDINGS OF STORMWATER AND WATER QUALITY MODEL USERS GROUP MEETING.**  
For primary bibliographic entry see Field 5G.  
W91-01188

**USER DEFINED CONDUITS IN THE EXTRAN BLOCK OF SWMM.**  
Tulane Univ., New Orleans, LA.  
M. L. Yaseen, and T. J. McGhee.  
IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 1-9, 4 fig, 2 ref.

Descriptors: \*Computer models, \*Conduits, \*Network design, \*Storm Water Management Model, \*Storm water, \*Urban hydrology, \*Urban runoff, \*Water supply development, Computer programs, EXTRAN, Finite difference methods, Flood routing, Floodwater, Hydraulic models, Louisiana, Mathematical studies, New Orleans, Pipelines, Pumping, Runoff, Simulation analysis.

## Effects On Water Of Man's Non-Water Activities—Group 4C

The drainage system in the City of New Orleans is extremely complex, containing conduits ranging from small circular pipes to very large open canals with complicated cross-sectional geometries. Invert slopes are low (sometimes zero) and permit the branching of flow in the downstream direction as well as flow reversal during runoff events. Both large and small conduits are surcharged and the entire flow must be pumped since the city is surrounded by levees. This network has been simulated using EPA's Storm Water Management Model (SWMM). SWMM provides a variety of alternative routing techniques, ranging from a quasi-steady state storage routing procedure in RUNOFF, to a finite difference solution of the Saint Venant equations in EXTRAN. The solution technique employed in EXTRAN is most suitable for New Orleans, but this block permits use of only six standard conduit shapes which do not always correspond to those which exist in the system. Since the system is not satisfactorily simulated by TRANSPORT, EXTRAN has been modified to permit the use of any shape whatsoever, whether it can be mathematically defined or not. The revised version of EXTRAN will accept and run data sets prepared for the standard program with no changes whatsoever and has been used to assess the effects of approximating unusual sewer shapes by the standard sections of EXTRAN. To determine whether the modifications to EXTRAN were correct, a network of rectangular and circular conduits, was analyzed using the modified version without user-defined conduits. Next, it was reanalyzed by sequentially replacing the rectangular and circular conduits one by one with user-defined shapes, which were actually rectangles and circles. This replacement created large differences in calculated flows and depths became progressively larger. This hydraulic radius computational error was corrected, yielding a maximum difference between flows commonly 0.01 cu ft/sec (cfs) and averaged 0.04 cfs. The results were compared with those shapes obtained for hydraulically equivalent rectangular and circular shapes. It was found that as the channels approach full flow, the differences diminished and at full flow the differences were negligible. (See also W91-01188) (Lantz-PTT) W91-01189

**REVISED RUNOFF BLOCK OF SWMM.**

Colorado Univ. at Denver. Dept. of Civil Engineering.

J. C. Y. Guo, and B. Urbonas.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 10-20, 4 figs, 6 tab, 5 ref.

Descriptors: \*Conduits, \*Model studies, \*Storm Water Management Model, \*Urban hydrology, \*Urban runoff, \*Water management, \*Water quality, Computer models, Data interpretation, Erosion, Flood routing, Floods, Hydraulic models, Pipelines, Pipes, Runoff, Simulation analysis, Storm runoff, Storm water management, Water quality management.

The Storm Water Management Model (SWMM) model consists of hydraulic watershed simulation, water quality modeling, hydraulic routing, contamination prediction, and erosion estimation, as well as other features to function as a complete water quality and quantity model. Changes were made to the Runoff Block of SWMM in 1974 to include the option of an overflow section for pipes and channels, and routing capability to model storage reservoirs such as detention ponds. In March 1985, the revised version of the Runoff Block of SWMM was converted to a microcomputer version and named UDSWM2-PC which includes only the rainfall and runoff subroutines required for stormwater drainage modeling. The software was modified to be capable of reading and routing hydrographs previously generated by software which uses the synthetic unit graph convolution to predict storm hydrographs. In this study the UDSWM2-PC was further modified to include a pipe sizing capability which enables the software to compute the required pipe diameter for the given hydrographs. The new version, named UDSWM3-PC is capable of simulating flood propagations in a drainage system with or without

existing pipes in the network. Results of this study indicate that the auto-pipe sizing greatly enhances the versatility of the UDSWM2-PC model. UDSWM3-PC can now be used for drainage basin analysis with or without existing storm sewers. The UDSWM2-PC model is inefficient with computer memory space. Approximately 90 arrays of 399 points are reserved for storing gutter and subbasin data. Only a portion of these arrays are utilized during computations depending on the total numbers of gutters and sub-basins in the drainage network. The remainder of the array space remains idle. The case study used only 4.5% of the reserved array space. (See also W91-01188) (Lantz-PTT) W91-01190

**SWMM-4.**

Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.

W. G. Huber, and R. E. Dickinson.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 21-32, 3 fig, 9 ref.

Descriptors: \*Management planning, \*Rainfall-runoff relationships, \*Storm Water Management Model, \*Storm runoff, \*Urban hydrology, \*Urban runoff, \*Water quality, Data interpretation, Model studies, Precipitation, Runoff, Storm water management, Water management, Water quality management.

Version 4 of the EPA Storm Water Management Model (SWMM) was released during September 1988. Improvements and changes include: full adaptation for microcomputer use, addition of natural channel geometry to the EXTRAN and Transport Blocks (using HEC-2 input formats), addition of subsurface quantity routing to the Runoff Block, ability to access recent National Weather Service precipitation and meteorological data and perform statistical analysis on these data, variable time steps in the Runoff Block, metrification of the Extran Block, and simplification of the input data. The model is available from the EPA Center for Exposure Assessment Modeling in Athens, Georgia. Version 4 of SWMM attempts to update and correct errors found in earlier versions, add new computational features, and make the program easier to run on a microcomputer without eliminating the option for use on main-frames. The conceptualization of the rainfall-runoff quality process remains the same, with attendant strengths and weaknesses. SWMM is expected to remain a familiar and improving tool for the analysis of urban hydrologic and similar problems for the foreseeable future. (See also W91-01188) (Lantz-PTT) W91-01191

**IMPROVEMENTS TO SURCHARGE CALCULATIONS IN EXTRAN.**

Brown and Caldwell, Seattle, WA.

For primary bibliographic entry see Field 7C. W91-01192

**URBAN RUNOFF MODELING FOR ADMINISTRATIVE PURPOSES.**

Wright Water Engineers, Inc., Denver, CO. W. P. Ruzzo.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 43-51.

Descriptors: \*Flood plain management, \*Hydrologic models, \*Rainfall-runoff relationships, \*Urban hydrology, \*Urban runoff, Administration, Management planning, Model studies, Public policy, Runoff, Urbanization.

Computer modeling of urban runoff has advanced in the last decade, particularly with the advent of the personal computer. The modeling techniques for simulating watershed responses and real-time rainfall have increased the ability to more precisely predict the runoff peaks and hydrographs. This advance in modeling capabilities has benefited the overall understanding of the physical sciences.

Input data as it relates to the actual end use of the model results has also advanced. In many cases the model results are used to develop a floodplain for regulatory purposes, or to develop hydrographs to design flood mitigation facilities. This aspect of modeling is more for administrative purposes and the decisions on the input data are not necessarily based on simulating the actual physical processes. Instead, decisions are made to facilitate the administration of the floodplain regulations or to provide a sound engineering basis for facilities which are designed for anticipated future development. Decisions were made during urban runoff modeling for several watersheds in the Denver area, are presented which required the model to account for anticipated future watershed conditions. The decisions are based on administrative considerations such as: (1) worst case scenarios, (2) limited jurisdictional control of development, (3) ability to accurately predict future conditions, and (4) local policies regarding stormwater management. The use of inadvertent detention that occurs upstream of road or railroad embankments, flood flows which become split from the main channel, projections of impervious land densities, and selection of watershed characteristics and routing patterns, are highlighted. (See also W91-01188) (Lantz-PTT) W91-01193

**MODELING STUDIES FOR THE CITY OF AUSTIN STORMWATER MONITORING PROGRAMS.**

Austin Environmental Protection Dept., TX. G. C. Chang, J. H. Parrish, and C. Soeur.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 52-61, 7 tab, 13 ref.

Descriptors: \*Austin, \*Model studies, \*Monitoring, \*Storm water management, \*Texas, \*Urban hydrology, \*Urban runoff, \*Water quality, Computer models, Computer programs, Filtration, Land use, Management planning, Urban watersheds, Water quality management.

Statistical modeling studies are presented for the City of Austin's two stormwater quality monitoring programs. One program monitors creeks of various large multiple-land use urban watersheds. The other program monitors flow and water quality of small single-land use urban watersheds and control structures. The stormwater quality and rainfall runoff data generally follow log-normal probability distributions. Based on the assumptions of normality or log-transformed normality, the data were analyzed using SAS computer programs. Regression equations relating runoff and rainfall variables were successfully developed for each watershed. Total and incremental pollutant loads for storms were regressed on runoff variables and antecedent rainfall conditions. Validation of the regression equation was dependent on statistical tests and specific precision standards. The amount of impervious cover in a watershed was chosen to represent the degree of urbanization for the watershed; the pollutant load per storm was found to linearly increase with the increase of watershed impervious cover. The pollutant concentration depended on various factors, many of which also relate to the amount of impervious cover. For the large watersheds, the concentration of many of those parameters was found to increase with impervious cover. For small urban watersheds these relationships do not exist; the concentration was dependent on the land use and maintenance. Results from two filtration basins and one wet pond support the City of Austin's watershed ordinance which specifies impervious cover limitations, and requires sedimentation and/or filtration basins for controlling stormwater quality for developing areas. (See also W91-01188) (Lantz-PTT) W91-01194

**APPLICATION OF SWMM IN THE NEW ORLEANS AREA.**

Tulane Univ., New Orleans, LA.

T. J. McGhee, and M. L. Yassenchak.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988,

## Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4C—Effects On Water Of Man's Non-Water Activities

Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 62-72, 2 fig. 1 tab, 6 ref.

Descriptors: \*Computer models, \*Louisiana, \*Model studies, \*New Orleans, \*Storm Water Management Model, \*Storm runoff, \*Urban hydrology, \*Urban runoff, Flood plain management, Runoff, Storm water management.

A review of recent applications of SWMM in the New Orleans Metropolitan area is presented. The city and adjoining areas of Jefferson Parish are entirely enclosed by levees, have very little surface relief, and have drainage systems which are thoroughly interconnected and subject to reversals of flow. Rainfall amounts are heavy. The normal annual precipitation exceeds 60 inches and individual storms may produce totals of 10-12 inches in as many hours. In recent years extensive property damage resulting from flooding has been the impetus for studies intended to improve the capacity of systems which, in at least some cases, were built to dewater marsh and swamp land and are now used to drain developed urban areas. The standard SWMM blocks RUNOFF, TRANSPORT, and EXTRAN have all been used depending upon the particular circumstance. In addition, certain modifications have been made which make the model more useful in the New Orleans region. Among these are the use of 'Standard Streets' in a manner analogous to that employed in the Chicago Drainage Model, inclusion of user-defined conduits in EXTRAN, and improvement of the pumping calculations in EXTRAN to better simulate a system with multiple pumps and variable suction and discharge bay elevations. Simulation of storms in excess of the drainage system capacity illustrated the deficiencies by showing discharges at internal points. The inadequate sections were increased in dimension and other modifications were made in the modeled system unit it was capable of conveying the flow to the pump stations without flooding. (See also W91-01188) (Lantz-PTT) W91-01195

#### USE OF SWMM/EXTRAN AND TR-20 TO DEVELOP REGIONAL STORMWATER DETENTION PLANS IN THE WASHINGTON, D.C. REGION.

Camp, Dresser and McKee, Inc., Annandale, VA. B. W. Mack, T. S. George, and J. P. Hartigan. IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 73-80, 1 fig, 1 tab, 3 ref.

Descriptors: \*District of Columbia, \*Storm Water Management Model, \*Urban hydrology, \*Urban runoff, Flood plain management, Management planning, Model studies, Runoff, Storm runoff, Storm water management, Urban watersheds, Water quality.

A regional approach to stormwater detention is the current trend for stormwater master plan development in the Washington metropolitan region. The development of criteria for locating and designing regional basins, and the modeling approaches used to maximize regional detention benefits on a watershed basis are addressed. Stormwater models were applied to develop a regional detention basin master plan for Fairfax County, Virginia, along with a preliminary stormwater management investigation for Montgomery County, Maryland. Following the selection of regional detention basin sites and the completion of conceptual designs the SWMM/EXTRAN model and the Soil Conservation Service TR-20 model were used to determine the water shed wide impacts of alternative detention systems. To assess regional benefits, various locational schemes were analyzed for both county plans. The Fairfax County plan included the design of maximum efficiency basins which utilize lower maximum release rates to compensate for areas not controlled by regional facilities. The regional detention basin network, recommended in the Montgomery County investigation, demonstrated the use of extended detention on top of a permanent pool for water quality benefits. In several cases, in addition to water quality benefits, this type of design reduced the post-development 2-year peak flows to levels less than pre-development condi-

tions. The TR-20 model was used to evaluate the watershed wide impacts of this type of design. In addition, a PC graphics package was developed to illustrate the watershed interactions of the routed TR-20 hydrographs. (See also W91-01188) (Author's abstract) W91-01196

#### APPLICATION OF QUAL II TO EXPLORE WASTELOAD ALLOCATION ALTERNATIVES.

Rhode Island Dept. of Environmental Management, Providence. For primary bibliographic entry see Field 5G. W91-01197

#### MULTI-MODEL MICRO-COMPUTER BASED WET DETENTION BASIN DESIGN METHODOLOGY.

North Carolina Dept. of Natural Resources and Community Development, Raleigh. Div. of Environmental Management. S. L. Harrell. IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 119-125, 3 fig, 6 ref, append.

Descriptors: \*Computer programs, \*Design standards, \*Detention reservoirs, \*Storm water management, \*Urban hydrology, \*Urban runoff, Flood control, Management planning, Runoff, Sedimentation, Spillways, Storm runoff, Water management.

A regulatory driven technical guidance manual, including a compendium of model series, is being synthesized from widely available manuals and models to assist developers in planning stormwater control mechanisms, and to aid municipal officials in reviewing these plans. Design of wet detention basins, usually consists of determining in four steps: (1) the minimum surface area of the permanent pool, (2) the storage volume that will detain a specified runoff, (3) principal spillway size and additional storage volume for flood control and sediment accumulation, and (4) the dam and emergency spillway design parameters. Tables of the required surface area for a given drainage area, impervious, and watershed characteristics are used for the first step. The remaining steps are completed using a LOTUS 123 spreadsheet model. (See also W91-01188) (Lantz-PTT) W91-01200

#### MODELING AND FIELD EVALUATIONS OF URBAN WET DETENTION PONDS.

North Carolina Univ. at Charlotte. Dept. of Civil Engineering. J. S. Wu.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 129-141, 1 fig, 8 tab, 17 ref.

Descriptors: \*Detention reservoirs, \*Field tests, \*Model studies, \*Urban hydrology, \*Urban runoff, \*Water quality, Management planning, North Carolina, Runoff, Water management, Water quality management.

An extensive stormwater sampling program was conducted on three existing urban wet detention ponds in the Piedmont region of North Carolina, and an EPA model was examined and verified for its usefulness in analyzing the water-quality improvement performance of urban wet detention ponds. By analyzing the pollutant removal data collected from eleven runoff events, a performance relationship was observed, permitting the incorporation of water quality improvement requirements into the proper sizing of wet detention ponds. To achieve a minimum level of urban runoff pollution control, the surface area ratio of detention ponds must be greater than 0.5%. Approximately 1% to 2% of the watershed area is needed for developing detention ponds to control 70% or more of the sediment load. (See also W91-01188) (Lantz-PTT) W91-01201

#### HYDROLOGIC DATA AUTOMATION USING AUTOCAD.

Kiowa Engineering Corp., Denver, CO. For primary bibliographic entry see Field 7C. W91-01202

#### DISTRIBUTED RAINFALL-RUNOFF MODELING BASED ON DIGITAL MAP DATABASE.

Colorado Univ. at Denver. Dept. of Civil Engineering. For primary bibliographic entry see Field 7C. W91-01203

#### PC-SYNOP, A RAINFALL ANALYSIS TOOL.

Woodward-Clyde Consultants, Oakland, CA. For primary bibliographic entry see Field 7C. W91-01204

#### COMPUTER AIDED PLANNING OF DRAINAGEWAY IMPROVEMENTS MADE EASY WITH LOTUS 1-2-3.

Greenhorn and O'Mara, Inc., Aurora, CO. For primary bibliographic entry see Field 7C. W91-01205

#### HYETOGRAPH COMPOSITING EFFECTS ON URBAN RUNOFF MODELLING.

Kiowa Engineering Corp., Denver, CO. For primary bibliographic entry see Field 7C. W91-01206

#### GULF COAST FLOOD ROUTING.

Wright Water Engineers, Inc., Denver, CO. For primary bibliographic entry see Field 2E. W91-01210

#### FORESTS AND THE TEMPERATURE OF UPLAND STREAMS IN WALES: A MODELING EXPLORATION OF THE BIOLOGICAL EFFECTS.

University Coll., Cardiff (Wales). School of Pure and Applied Biology. For primary bibliographic entry see Field 2E. W91-01343

#### CULTURAL EUTROPHICATION OF WEST POINT LAKE—A 10-YEAR STUDY.

Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures. For primary bibliographic entry see Field 5C. W91-01354

#### EFFECT OF HYDROPOWER PEAKING FLOW FLUCTUATIONS ON COMMUNITY STRUCTURE AND FEEDING GUILDS OF INVERTEBRATES COLONIZING ARTIFICIAL SUBSTRATES IN A LARGE IMPOUNDED RIVER.

Minnesota Univ., St. Paul. Dept. of Forest Resources. N. H. Troelstrup, and G. L. Hergenrader. Hydrobiologia HYDRB8, Vol. 199, No. 3, p 217-228, July 31, 1990. 2 fig, 4 tab, 41 ref.

Descriptors: \*Aquatic insects, \*Dam effects, \*Hydroelectric power, \*Limnology, \*Macroinvertebrates, \*Missouri River, \*Nebraska, \*Reservoir releases, \*Species diversity, \*Stream discharge, \*Stream ecology, Abundance, Artificial substrates, Caddisflies, Depth, Diurnal variation, Food habits, Impoundments, Mayflies, Midges, Monitoring, Oligochaetes, Unsteady flow.

Artificial substrates were used to monitor the invertebrate communities below a power peaking impoundment and a flow re-regulating impoundment on the Missouri River in Northeastern Nebraska. Invertebrate communities on shallow samplers subjected to exposure from diel fluctuations in flow averaged 3 taxa per sampler and 91 organisms per square meter. In the absence of diel fluctuations, number of taxa per sampler increased to 12 and mean densities increased to 743 per square meter. Fluctuating discharges had no significant effect on numbers of taxa or densities on

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continually submerged artificial substrates. However, greater numbers of taxa and total densities were observed on deep (107 cm) versus shallow (30 cm) samplers below both impoundments. Polycentropodidae (Trichoptera), Chironomidae (Diptera) and Oligochaeta were observed to tolerate diel fluctuations and exposure below Fort Randall Dam while Hydropsychidae (Trichoptera) and Heptageniidae (Ephemeroptera) were extremely intolerant. Collector-gathers and predator-gulferers were the predominant functional groups colonizing samplers below both impoundments. Higher numbers of collector-gathers, collector-filterers, and scrapers were observed from samplers in the absence of diel flow fluctuations. These findings corroborate results from a number of other investigations, separated in space and time. Examined collectively, these studies provide the framework for understanding power peaking as a stress to benthic stream communities. (Author's abstract)

W91-01357

#### BUFFERING CAPACITY OF COAL MINE SPOILS AND FLY ASH AS A FACTOR IN THE PROTECTION OF THE AQUATIC ENVIRONMENT.

Polish Academy of Sciences, Zabrze. Inst. of Environmental Engineering.

For primary bibliographic entry see Field 5G. W91-01455

#### ENVIRONMENTAL IMPACTS OF DEVELOPMENT ON WETLANDS IN ARID AND SEMI-ARID LANDS.

University Coll., London (England). Dept. of Geography.

For primary bibliographic entry see Field 6G. W91-01462

#### CHANGES IN STREAM MORPHOLOGY AND STORM TRANSPORT OF SEDIMENT FOLLOWING WATERSHED DISTURBANCE.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.

For primary bibliographic entry see Field 2J. W91-01505

#### PROBLEMS IN DETERMINING THE RETURN OF A WATERSHED TO PRETREATMENT CONDITIONS: TECHNIQUES APPLIED TO A STUDY AT CASPAR CREEK, CALIFORNIA.

Forest Service, Arcadia, CA.

R. B. Thomas.  
Water Resources Research WRAQ, Vol. 26, No. 9, p 2079-2087, September 1990. 7 fig, 6 tab, 14 ref.

Descriptors: \*Flood peak, \*Forest watersheds, \*Land use, \*Logging, \*Rainfall-runoff relationships, \*Road construction, \*Storm runoff, \*Suspended sediments, Land management, Streamflow, Watershed management.

Using a previously treated basin as a control in subsequent paired watershed studies requires the control to be stable. Basin stability can be assessed in many ways, some of which were investigated for the South Fork of Caspar Creek in northern California. This basin is recovering from logging and road building in the early 1970s. Three storm-based discharge characteristics (peak discharge, quick flow, and total storm flow), daily flows, and concentration of suspended sediment were studied to see if the South Fork can be used as a control in a second experiment. Mean sediment concentration in three discharge classes and regression parameters for the other data were tested to estimate remaining treatment effects relative to the North Fork. Patterns of change were similar for most data, with rises in response followed by returns toward pretreatment conditions. The storm and sediment data showed few significant differences, but tests on daily flows indicated that differences still exist. The overall evidence suggests that the South Fork has returned to near pretreatment conditions. Better sediment data are needed for studies of the effects of land management. (Author's abstract)

W91-01523

#### BACTERIAL PRODUCTION AND RESPIRATION IN THE LAKES OF DIFFERENT TYPES.

Akademiya Nauk SSSR, Leningrad. Inst. Ozerovodeniya.

For primary bibliographic entry see Field 2H.

W91-01611

#### RESPONSE OF COASTAL ZONE MANAGEMENT PROGRAMS TO SEA LEVEL RISE IN THE UNITED STATES.

Washington Univ., Seattle. Inst. for Marine Studies.

For primary bibliographic entry see Field 6B.

W91-01619

#### VEGETATION DYNAMICS IN IMPOUNDED MARSHES ALONG THE INDIAN RIVER LAGOON, FLORIDA, USA.

Florida Medical Entomology Lab., Vero Beach. J. R. Rey, R. A. Crossman, and T. R. Kain.

Environmental Management EMNGDC, Vol. 14, No. 3, p 397-409, March/April 1990. 7 fig, 5 tab, 28 ref. Office of Coastal Zone Management-NOAA Grants CM-47, CM-73, and CM-93.

Descriptors: \*Florida, \*Mangrove swamps, \*Marsh management, \*Marsh plants, \*Salt marshes, \*Vegetation establishment, \*Water resources development, \*Wetlands, Batis, Glassworts, Halophytes, Reservoirs, Succession, Vegetation regrowth, Water control, Water management.

Data are presented on the vegetation dynamics of two impounded marshes along the Indian River Lagoon, in east-central Florida. Vegetation in one of the marshes (IRC 12) was totally eliminated by overflooding and by hypersaline conditions (salinities over 100 ppt) that developed there in 1979 after the culvert connecting the marsh with the lagoon was closed. Over 20% recovery of the herbaceous halophytes *Salicornia virginica*, *S. bigelovii*, and *Batis maritima* was observed at that site after the culvert was reopened in 1982, but total cover in the marsh remains well below the original 75%. No recovery of mangroves was observed at this site. The second site (SLC 24), while remaining isolated from the lagoon during much of the study, did not suffer the complete elimination of vegetation experienced at the first site. At this location, mangroves increased in cover and frequency with a concomitant decrease in herbaceous halophytes. Considerable damage to the vegetation was evident at IRC 12 when the impoundment was closed and flooded for mosquito control in 1986. Although the damage was temporary, its occurrence emphasizes the need for planning and constant monitoring and adjustment of management details as conditions within particular marshes change. Storms and hurricanes may be important in promoting a replacement of black mangroves by red mangroves in closed impoundments because the former cannot tolerate pneumatophore submergence for long periods of time. (Author's abstract)

W91-01636

#### HYDRAULIC SHOCK LOADINGS OF WASTEWATER TREATMENT SYSTEM TO URBAN RAINFALL-RUNOFF (EFFETS CHOCES HYDRAULIQUES DES EAUX USEES DE RUISSELLEMENT PLUVIAL URBAIN SUR UN SYSTEME DE TRAITEMENT DES EAUX).

Institut National de la Recherche Scientifique, Rimouski (Quebec).

For primary bibliographic entry see Field 5D.

W91-01638

#### CHANGES IN WEST AFRICAN SAVANNA AGRICULTURE IN RESPONSE TO GROWING POPULATION AND CONTINUING LOW RAINFALL.

International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).

For primary bibliographic entry see Field 6D. W91-01683

#### PEAK-FLOW CHARACTERISTICS OF SMALL URBAN DRAINAGE ALONG THE WASATCH FRONT, UTAH.

Geological Survey, Salt Lake City, UT. Water Resources Div.

K. L. Lindskov, and K. R. Thompson.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4095, 1989. 38p, 17 fig, 7 tab, 13 ref.

Descriptors: \*Model studies, \*Peak flow, \*Rainfall-runoff relationships, \*Storm runoff, \*Urban hydrology, \*Urban runoff, \*Utah, Peak discharge, Urban drainage, Urban watersheds, Wasatch Front.

Designers and planners for local, State, and Federal agencies need up-to-date methods for determining peak-flow characteristics for urban drainages along the Wasatch Front, Utah. This report summarizes methods used to develop equations that estimate peak-flows for small urban drainages along the Wasatch Front. Mathematical equations were developed that estimate peak flows for recurrence intervals of 2, 5, 10, 25, 50 and 100 years, for small urban drainages. Data entry to the equations requires measurements of basin slope, size and percent impervious area. Rainfall and runoff data collected from eight urban drainages along the Wasatch Front from 1984-86, were used to calibrate a rainfall-runoff model called DR3M-II. Rainfall data collected from 1948-83 at the National Weather Service Salt Lake City Airport station provided additional long-term data to the calibrated models. Log Pearson fits made to the peak flow data were used to estimate the recurrence interval peaks for each basin. Paired stations on Little Cottonwood Creek near Salt Lake City were used to help determine the effects of intervening urban drainage on peaks of larger streams. In general, peaks on larger streams caused by snowmelt and peaks caused by rainfall (where urban areas may have a significant effect) did not occur simultaneously. (USGS)

W91-01834

#### RELATIONSHIPS BETWEEN WETLAND FRAGMENTATION AND RECENT HYDROLOGIC CHANGES IN A DELTAIC COAST.

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.

For primary bibliographic entry see Field 2L.

W91-01903

#### HEAVY METAL ACCUMULATION AND TRANSPORT THROUGH DETENTION PONDS RECEIVING HIGHWAY RUNOFF.

University of Central Florida, Orlando. Dept. of Civil Engineering and Environmental Sciences.

For primary bibliographic entry see Field 5B.

W91-01995

#### 4D. Watershed Protection

#### SEDIMENT-SOURCE DATA FOR FOUR BASINS TRIBUTARY TO LAKE TAHOE, CALIFORNIA AND NEVADA, AUGUST 1983-JUNE 1988.

Geological Survey, Sacramento, CA. Water Resources Div.

For primary bibliographic entry see Field 2J.

W91-01847

#### SUSPENDED SEDIMENT AND BED LOAD PROBLEMS OF THE UPPER RHINE.

Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).

E. Goltz.

Catena, Vol. 17, No. 2, p 127-140, April 1990. 8 fig, 2 tab, 20 ref.

Descriptors: \*Bed load, \*Dam effects, \*Erosion, \*Erosion control, \*Regulated flow, \*Rhine River, \*Sediment control, \*Sedimentation, \*Suspended sediments, Gravel, Mine wastes, Particle size, Rivers, Sand, Wastewater.

## Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4D—Watershed Protection

The regulation of the southern Upper Rhine by dams down to Iffezheim has considerably changed the sediment balance of the stream. In the impounded sections fine-grained sediments are deposited, narrowing the cross section and impeding high-water discharge. The high illite content of the suspended material indicates that a considerable part of the settling sediment is derived from Alsatian potassium mining wastewaters. In the freely flowing Rhine downstream of Iffezheim, erosion occurs. Although the degradation of the riverbed downstream of the Iffezheim dam is prevented successfully by artificial addition of gravel, this has no positive influence on the erosion taking place farther north. This becomes apparent both in the petrographic composition of the bed load material as well as in its particle size distribution. Medium-grained to coarse gravel with high carbonate rock content is deposited upstream of Speyer. Downstream of Speyer, sand and fine gravel rich in crystalline components are taken up from the river bottom. This situation might be improved by appropriate addition of sand and fine gravel downstream of Iffezheim. (Author's abstract) W91-01871

## 5. WATER QUALITY MANAGEMENT AND PROTECTION

### 5A. Identification Of Pollutants

#### APPLICATION OF A HOLLOW-FIBER, TANGENTIAL-FLOW DEVICE FOR SAMPLING SUSPENDED BACTERIA AND PARTICLES FROM NATURAL WATERS.

Geological Survey, Menlo Park, CA. J. S. Kuwabara, and R. W. Harvey. Journal of Environmental Quality JEQA, Vol. 19, No. 3, p 625-629, July/September 1990. 1 fig, 3 tab, 25 ref.

Descriptors: \*Dewatering, \*Filtration, \*Instrumentation, \*Membrane filters, \*Pollutant identification, \*Samplers, \*Water sampling, Analytical techniques, Bacterial analysis, Hollow-fiber filters, Suspended particles, Tangential flow, Water analysis.

Increasing interest in suspended particles that control transport, partitioning, and bioavailability of a variety of contaminants in natural waters has necessitated the development of efficient dewatering/particle-concentration devices. The design and application of a hollow-fiber tangential-flow filtration device for concentration of bacteria and suspended particles from large volumes of surface water and groundwater samples (i.e., hundreds of liters) was described. The device is composed of a filtration module, containing two all polypropylene, hollow-fiber tangential-flow filtration cartridges (0.2 microm pore size), and a pump module. Filtrate flux rates (4-8 L/min) are equal to or faster than those of other devices that are based on continuous flow centrifugation and plate and frame filtration. Particle recovery efficiencies for inorganic particles (approximately 90%) were similar to other dewatering devices, but microbial cell recoveries (30-90%) were greatly improved by this technique relative to other currently available methods. Although requirements for operation and maintenance of the device are minimal, its size, as with other dewatering devices, limits its applicability at remote sites. Nevertheless, it has proven useful for sample collection in studies involving microbial transport and analysis of particle-associated trace inorganic solutes. (Author's abstract) W91-01031

#### VARIABILITY OF DIATOM CONCENTRATIONS AND ACCUMULATION RATES IN SEDIMENTS OF A SMALL LAKE BASIN.

University Coll., London (England). Palaeoecology Research Unit. For primary bibliographic entry see Field 2H. W91-01049

#### STUDIES ON THE ABILITY OF WATER HYACINTH (EICHORNIA CRASSIPES) TO BIO-

#### CONCENTRATE AND BIOMONITOR AQUATIC MERCURY.

Berampur Univ. (India). Dept. of Botany. M. Lenka, K. K. Panda, and B. B. Panda. Environmental Pollution ENPOEK, Vol. 66, No. 1, p 89-99, 1990. 4 fig, 3 tab, 15 ref.

Descriptors: \*Aquatic plants, \*Bioindicators, \*Biological magnification, \*Mercury, \*Monitoring, \*Water hyacinth, Bioaccumulation, Genotoxicity, Plant growth, Spectrophotometers, Water pollution control.

Water hyacinth (*Eichhornia crassipes*) plants were employed to assess bioconcentration and genotoxicity of aquatic mercury. Plants were exposed to water contaminated with mercuric chloride (MC) or phenyl mercuric acetate (PMA) at 0.001 to 1.0 mg/L or mercury contaminated effluent from a chloralkali plant for various periods of 4 to 96 hours. Root samples taken after 4, 8, 12, 24, 48, 72, and 96 hours of exposure were analyzed for bioconcentration of mercury spectrophotometrically, and the root meristems were fixed in aceto-ethanol for cytological analysis to determine the frequencies of cells with micronuclei (MNC). Ethyl methane sulfonate and tap water served as positive and negative controls, respectively. The results indicated that bioconcentration of mercury in root tissue was both time-dependent and concentration-dependent, providing evidence that water hyacinth is a good absorbent of aquatic mercury. The frequency of root meristematic cells with MNC followed a concentration-response. The findings indicate the potential of water hyacinth plants for in situ monitoring and for mitigation of aquatic mercury pollution. (Author's abstract) W91-01112

#### HEAVY METAL CONCENTRATION IN TELESCOPIUM FROM DARWIN HARBOUR, N.T., AUSTRALIA.

Northern Territory Univ., Darwin (Australia). School of Chemistry. N. Peerzada, C. Eastbrook, and M. Guinea. Marine Pollution Bulletin MPNBZ, Vol. 21, No. 6, p 307-308, June 1990. 1 fig, 1 tab, 9 ref.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Darwin Harbour, \*Gastropods, \*Pollutant identification, \*Telescopium, \*Water pollution sources, Atomic absorption spectrometry, Australia, Cadmium, Copper, Elizabeth River, Frances Bay, Path of pollutants, Race Course Creek, Rapid Creek, Trace metals, Wastewater pollution, Zinc.

Some gastropods have the clear potential to act as indicators of trace metals. *Telescopium* which is widely eaten by the aborigines is a sedentary filter feeder and likely to show the accumulation of heavy metal in Darwin Harbour. Samples of *telescopium* were collected from 11 sites around Darwin Harbour; at least, 15-20 specimens were collected from each site. The samples were digested and analyzed by flame atomic absorption spectrophotometry with a Varian AA1475. No background correction was used. The level of lead found ranged from undetectable to 8.99 microgm/g. High levels of lead were found in samples from Rapid Creek and Frances Bay. The highest levels were at Rapid Creek which received some treated sewage and storm runoff. Frances Bay received some Macerated sewage. No lead was detected elsewhere. High concentrations of Cd, 20.6 microgm/g, Zn, 1199.47 microgm/g, and Cu 72.05 microgm/g, were found at Race Course Creek, which receives sewage. The highest Cd levels were at Elizabeth River near boat ramps, landfills and sewage outlets. The concentration of Zn in samples from Rapid Creek ranged from 19.70 to 53.69 microgm/g. Oysters from the same area had Zn concentrations of 661.0 microgm/g indicating that *telescopium* is not a good accumulator of zinc compared to oysters. The concentration of Cu in the *telescopium*, 72.05 microgm/g, was double the concentration found in the oysters found in these creeks, 30 to 39 microgm/g. The concentration of Pb, Zn, Cu, Mn, Co, and Ni were generally below the recommended limit with the exception of Pb. (King-PTT) W91-01164

#### NONPRIORITY ANALYSIS OF THE WASTEWATER STREAMS OF FOUR DYE MANUFACTURING FACILITIES.

Rutgers - The State Univ., New Brunswick, NJ. Dept. of Food Science.

L. H. Alaimo, T. G. Hartman, R. T. Rosen, L. J. McGeorge, and R. W. Meyer.

Research Journal of the Water Pollution Control Federation JWPFAS, Vol. 62, No. 5, p 665-669, July/August 1990. 2 tab, 33 ref.

Descriptors: \*Analytical methods, \*Dye industry wastes, \*Industrial wastes, \*Pollutant identification, \*Priority pollutants, \*Wastewater analysis, Chloroaniline, Chlorotoluene, Dichloroaniline, Diethyl phthalate, Gas chromatography, Mass spectrometry, High performance liquid chromatography, Mass spectrometry, Methylbenzenesulfonamide, Organic compounds, Toxicity, Trinitrophenol, Triphenyl.

The wastestreams of four dye manufacturing facilities were analyzed for the presence of dyes, dye precursors and intermediates using a battery of mass spectrometric techniques. Wastewater samples were extracted and concentrated using liquid/liquid extraction and XAD-2 resin adsorption methodology. Priority pollution analysis was conducted using EPA Method 625. Extracts were also analyzed using direct on-column injection capillary gas chromatography/mass spectrometry and desorption ionization techniques including thermospray high performance liquid chromatography/mass spectrometry and fast atom bombardment mass spectrometry. Elemental formulas for unknown compounds present at levels above 100 ppb were derived from accurate mass measurements using high-resolution mass spectrometry. The combined analytical data identified 313 compounds in the various wastewater streams. Partial structural characterization was obtained for an additional 94 compounds. A total of 107 unknown compounds were also detected. Only nine priority pollutants were detected using standard EPA methodology. The identified compounds were searched for genotoxic potential using the Gene-Tox database and 32 of them were identified as having genotoxic properties. The most concentrated of these were: chlorotoluene, 149 ug/L; diethyl phthalate, 104 ug/L; triphenyl, 99 ug/L; dichloroaniline, 77 ug/L; chloroaniline, 59 ug/L; methylbenzenesulfonamide, 51 ug/L; and trinitrophenol, 46 ug/L. (Author's abstract) W91-01172

#### RECOVERY OF 3-CHLORO-4-(DICHLORO-METHYL)-5-HYDROXY-2(5H)-FURANONE FROM WATER SAMPLES ON XAD RESINS AND THE EFFECT OF CHLORINE ON ITS MUTAGENICITY.

Health Effects Research Lab., Research Triangle Park, NC. Genetic Toxicology Div.

K. M. Schenck, J. R. Meier, H. P. Ringhand, and F. C. Kofler.

Environmental Science and Technology ESTHAG, Vol. 24, No. 6, p 863-867, June 1990. 4 fig, 2 tab, 18 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Chlorination, \*Chlorine, \*Drinking water, \*Mutagens, \*Pollutant identification, \*Public health, \*Water pollution effects, Adsorption, Bacterial physiology, Humic substances, Laboratory methods, Residual chlorine.

The potent bacterial mutagen 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone (MX) has been found to significantly contribute to the mutagenic activity in chlorinated drinking water. Reliable assessment of the possible effects of MX on human health requires an accurate measurement of the MX levels present in drinking water samples. This study indicates that optimal recovery from aqueous solution is obtained by adsorption of MX at acidic pH on XAD-8 Amberlite resin. In addition, in the presence of chlorine, the concentration of MX decreases at a rate that increases with increasing chlorine concentration. The data suggest that the MX level present in tap water is dependent not only on the amount of MX produced by the chlorination of humic substances, but also on the rate of

## Identification Of Pollutants—Group 5A

MX degradation by residual chlorine. (D'Agostino-PTT)  
W91-01181

**ECOLOGICAL MONITORING: THE NEED FOR A STANDARD.**  
Wimpol Ltd., Swindon (England).  
For primary bibliographic entry see Field 5G.  
W91-01216

**MULTI-ELEMENT ANALYSIS OF NATURAL WATER USING INDUCTIVELY COUPLED PLASMA-SOURCE MASS SPECTROMETRY (ICP-MS).**  
Surrey Univ., Guildford (England). Dept. of Chemistry.  
N. I. Ward.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 197-204, 3 fig, 1 tab, 23 ref.

Descriptors: \*Mass spectrometry, \*Pollutant identification, \*Trace elements, Aluminum, Atomic absorption spectrophotometry, Drinking water, Groundwater, Surface water, United Kingdom.

Inductively coupled plasma-source mass spectrometry (ICP-MS) offers exceptional ultra-trace multi-element sensitivity which is vital for measuring the concentrations which normally exist at microgram/milliliter or microgram/L in natural waters. ICP-MS provides simple spectra of isotopic elemental data covering a linear dynamic range of six orders of magnitude, with typical detection limits (3 sigma) for the majority of elements lying between 0.01 and 0.1 microgram/L. ICP-MS also offers the ability to measure isotope ratios enabling isotope dilution studies or the use of stable isotope tracers. Comparison is made with other established analytical methods (neutron activation analysis, atomic absorption spectrometry, ICP-OES, SS-MS, etc.) for the throughput/cost per determination analysis of natural waters. The preliminary assessment of the elemental composition of various British water samples collected from reservoirs (before filtration), after separation (filtration/treatment), and from consumer's tap-flow sites covering various rural and urban locations of thirteen water authority catchment areas revealed a wide variation in elemental content, especially Al as assessed by ICP-MS. (See also W91-01211) (Author's abstract)  
W91-01219

# NECESSITY OF BIOASSAYS IN WATER QUALITY MONITORING.

Institut fuer Wasserforschung G.m.b.H. Dortmund, Schwerte (Germany, F.R.).  
C. Schmidt.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 245-254, 9 fig, 5 tab, 12 ref.

Descriptors: \*Bioassay, \*Monitoring, \*Pollutant identification, \*Toxicity, \*Water pollution effects, Algae, Bioindicators, Fluorescence, Rhine River, Water quality.

A water quality management program requires continuous supervision of surface water and groundwater. The complexity of natural systems makes it difficult to determine the toxic potential of a substance in situ. Short-term changes of water quality cannot be detected by discontinuous sampling. Many chemicals cause biological reactions at very low concentrations and toxic substances almost always appear in a mixture. The biological effects of such a mixture cannot be determined by chemical analysis since water quality parameters like hardness, oxygen or pH influence the toxic effects. Consequently, it is the knowledge of toxic substances, water quality data, organisms and their reactions, which allows an estimate of toxicological potential. Depending on the specific problems, additional to the tests on the degradability of substances or tests on long-term effects, alarm-tests

with a very short reaction time are required for water quality monitoring. These bioassays should use organisms from different trophic levels (i.e., bacteria, algae, zooplankton, higher plants and fishes). Bioassays for water quality monitoring purposes should be sensitive to a wide spectrum of substances and insensitive to matrix effects. They must show a response within minutes, have a high degree of automation and no time-consuming servicing; they must additionally have low construction and working costs. An algae fluorescence bioassay was used to measure nitrite, nitrate, phosphate, and ammonia in the River Ruhr. An automated version of this algae fluorescence test is being used to monitor surface water quality along the Rhine River. (See also W91-01211) (Author's abstract)  
W91-01225

# PHOTOGRAPHIC SCREENING PROCEDURE FOR TRIAZINE HERBICIDES IN WATER USING AN ENHANCED LUMINESCENT IMMUNOASSAY.

Surrey Univ., Guildford (England). Dept. of Biochemistry.

A. Hardcastle, W. Aherne, and G. Thorpe.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 293-296, 1 fig, 2 tab, 3 ref.

Descriptors: \*Herbicides, \*Immunoassay, \*Photography, \*Triazines, \*Water analysis, Atrazine, Laboratory methods, Pollutant identification, Quantitative analysis, Simazine.

The detection and quantitation of triazine herbicides in large numbers of water samples at the maximum allowable concentration of 100 nanograms/L poses a problem to the water analyst. The feasibility of using an enhanced luminescent immunoassay, with a photographic endpoint, for screening samples was assessed. Antisera to atrazine and simazine were raised in sheep and purified for the best immunological activity. Flexible round-bottomed microtiter plates were coated for at least 12 hr at 4 C with 200 microliters of purified antiserum diluted in barbitone buffer. Plates can be stored for several weeks before use. The concentration of coating antiserum and Horseradish Peroxidase (HRPO) label were optimized for the required assay incubation time. A Dynatec Microlite camera luminometer was used to record the light intensity produced in each well onto high-speed film (Polaroid 612). Visual estimates of atrazine concentration compared well with quantitative assay results. Large numbers of samples can be analyzed quickly using simple equipment. It is suggested that with further evaluation and validation, the procedure may represent an ideal method for screening samples for the presence of triazine. (See also W91-01211) (Geiger-PTT)  
W91-01230

# TOXICITY OF WATER EXTRACTS OF HAZARDOUS WASTE.

Wyższa Szkoła Inżynierska, Zielona Góra (Poland).

For primary bibliographic entry see Field 5C.  
W91-01231

# SHORE-BASED MICROBIOLOGICAL SAMPLING OF RECREATIONAL/BATHING WATERS: POSSIBLE PROBLEMS AND SOLUTIONS.

Clyde River Purification Board, East Kilbride (Scotland).  
D. P. Milne.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 331-336, 3 fig, 2 tab, 10 ref.

Descriptors: \*Bioindicators, \*Coliforms, \*Mathematical models, \*Sampling, \*Swimming, \*Water analysis, \*Water quality, \*Water quality standards, Advection, Estuaries, Model studies, Tidal effects, Water quality control, Wind velocity.

Tidal state, wind velocity, and density structure can influence the near-shore levels of bacterial indicators by altering the distribution of discharged effluent. Field data from the Firth of Clyde, Scotland illustrate that the careful choosing of the sampling time can make a difference of up to two orders of magnitude in the fecal coliform level and, therefore, dictate whether recreational waters comply or not with the European Community Bathing Waters Directive. The Clyde River Purification Board and the University of Strathclyde's Department of Applied Physics have formed a research group to develop a mathematical microbiological model which may be applied to coastal waters. The model is based on the continuity equation which relates the advective and diffusive fluxes to fecal coliform input and inactivation. The model should prove to be an invaluable management tool in predicting whether an area is likely to comply, over a bathing season, and in planning the necessary developments required to make non-complying waters meet the Directive's standards. (See also W91-01211) (Geiger-PTT)  
W91-01234

# BIOFILMS: DETECTION, IMPLICATIONS AND SOLUTIONS.

Centre for Applied Microbiology Research, Salisbury (England).

For primary bibliographic entry see Field 5F.  
W91-01239

# BETA-GLUCURONIDASE AS A RAPID COLORIMETRIC ASSAY FOR E. COLI IN WATER AND SEWAGE SAMPLES.

Surrey Univ., Guildford (England). Dept. of Microbiology.

M. R. Adams, and S. M. Grubb.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 391-395, 4 fig, 3 ref.

Descriptors: \*Analytical techniques, \*Bacterial analysis, \*Colorimetry, \*Enzymes, \*Escherichia coli, \*Pollutant identification, \*Water analysis, Bioassay, Coliforms, Fluorometry, Quantitative analysis, Shigella.

Production of the enzyme beta-glucuronidase by bacteria is largely confined to *Escherichia coli* and, to a lesser extent, its close relatives in the genus *Shigella*. Approximately 95% of *E. coli* strains demonstrate this activity and its has been employed as a diagnostic feature in the identification and enumeration of the organism. In these tests, enzyme activity is invariably scored as present or absent based upon the production of color or fluorescence from an appropriate synthetic substrate. An alternative approach uses a quantitative assessment of color development as a means of directly enumerating the organism. Lake water and raw sewage were used to compare the present test with two reference methods in a competitive situation involving an unknown mixture of environmental organisms including *E. coli*. The lake water sample was concentrated to achieve detection in one day (detection time 6.55 hr). Both neat and diluted sewage were used. The undiluted sewage sample appeared to produce an inherent background color that interfered with the assessment of the detection time. The diluted sample was found more suitable for use with this method (detection time 6.4 hr). This method of quantitative assessment of the activity of the enzyme beta-glucuronidase as a means of directly enumerating *E. coli* showed promise as a rapid technique suitable for automation. (See also W91-01211) (Geiger-PTT)  
W91-01242

# ROTAVIRUS AS A VIRAL INDICATOR IN SHELLFISH.

Surrey Univ., Guildford (England). Dept. of Microbiology.

M. R. Adams, and D. A. Lloyd.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5A—Identification Of Pollutants

20 April, 1989. Pergamon Press, New York. 1989. p 397-404, 13 ref.

Descriptors: \*Analytical techniques, \*Bioindicators, \*Pollutant identification, \*Rotaviruses, \*Shellfish, \*Viruses, Antibiotics, Bacteria, Enzymes, Heavy metals, Humic acids, Immunoassay, Separation techniques, Toxicity.

An immunoperoxidase procedure has enabled rotavirus to be assayed in under 24 hr in samples of shellfish. Primary antibody tagging uses hyperimmune bovine anti-rotavirus serum while secondary antibody tagging uses rabbit anti-bovine serum conjugated with horseradish peroxidase. An elution-precipitation procedure or an alternative extraction procedure was used to concentrate the sample. Toxic components which interfere with virus uptake and cell metabolism such as heavy metals, humic acids and unspecified high molecular weight compounds must be removed by sewage flocculants, diphenylthiocarbazone (chelating agent), or Sephadex beads. In addition, dilution of the final extracts reduces toxicity to animal cells, and reduction in time of exposure reduces cytotoxic effects while allowing viral adsorption to take place. To assay viruses in animal cells grown in a nutrient-rich environment, bacteria must be removed by antibiotics, solvent extraction, or filter sterilization. Using the present methods, rotaviruses may prove to be a successful indicator organism for the presence of less culturable viruses in polluted waters. (See also W91-01211) (Geiger-PTT) W91-01243

**COMPARISON OF MEASURED INSTREAM BIOLOGICAL RESPONSES WITH RESPONSES PREDICTED USING THE CERIODAPHNIA DUBIA CHRONIC TOXICITY TEST.** North Carolina Dept. of Natural Resources and Community Development, Raleigh. Div. of Environmental Management. For primary bibliographic entry see Field 5C. W91-01261

**EFFECT OF SEDIMENT SPATIAL VARIANCE AND COLLECTION METHOD ON CLADOCERAN TOXICITY AND INDIGENOUS MICROBIAL ACTIVITY DETERMINATIONS.** Wright State Univ., Dayton, OH. Dept. of Biological Sciences. B. L. Stemmer, G. A. Burton, and G. Sasson-Brickson. Environmental Toxicology and Chemistry ETODG, Vol. 9, No. 8, p 1035-1044, August 1990. 4 fig, 2 tab, 36 ref.

Descriptors: \*Creosote, \*Daphnia, \*Path of pollutants, \*Pollutant identification, \*Quality control, \*River sediments, \*Sampling, \*Sediment contamination, \*Toxicity, \*Toxicology, Analysis of variance, Bioassay, Enzymes, Mortality, Particle size, Sediment sampler, Spatial variation, Survival, Waterfleas.

Quantitative assessments of sediment quality frequently are based on data derived from sediments collected by grab sampling. Often only one sediment or one composited sediment is collected at a sample site, thereby preventing any determination of spatial variance. The significance of spatial variance and collection method on cladoceran toxicity and indigenous microbial activities was determined at a creosote contaminated site in the Little Scioto River in Marion County, Ohio. Replicate sediments were collected on two occasions from a horizontal sample grid (110 sq m and 1.4 sq m) using an Ekman Dredge and hand core. Sediment particle size fractions did not vary significantly between replicate grab samples. Survival of *Daphnia magna* and *Ceriodaphnia dubia* in 48 hour solid phase exposures varied, however, from 1 to 100% horizontally and vertically at the test site. Percent survival and beta-glucosidase activity decreased in sediment sections below a 4 to 5 cm depth. Dredged sediments produced less toxicity to the daphnids than did core collected samples. The coefficient of variance was high (> 40%) for both survival and hydrolase activities (alkaline phosphatase, beta-galactosidase and beta-glucosidase) be-

tween horizontal sediment replicates collected by either dredge or core. Subsample variance, however, was small (< 20%). These results highlight the important role that sediment heterogeneity and collection method have on sediment quality assessments. (Author's abstract) W91-01262

**YOLK RETINOID (VITAMIN A) IN EGGS OF THE HERRING GULL AND CORRELATIONS WITH POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS.** Ottawa Univ. (Ontario). Dept. of Biology. For primary bibliographic entry see Field 5C. W91-01264

**TOXICITY OF FLUORANTHENE IN SEDIMENT TO MARINE AMPHIPODS: A TEST OF THE EQUILIBRIUM PARTITIONING APPROACH TO SEDIMENT QUALITY CRITERIA.** Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center. For primary bibliographic entry see Field 5C. W91-01265

**SIMULTANEOUS DUAL COLUMN, DUAL-DETECTOR GAS CHROMATOGRAPHIC DETERMINATION OF CHLORINATED PESTICIDES AND POLYCHLORINATED BIPHENYLS IN ENVIRONMENTAL SAMPLES.** Battelle Ocean Sciences, Duxbury, MA. G. S. Durell, and T. C. Sauer. Analytical Chemistry ANCHAM, Vol. 62, No. 17, p 1867-1871, September 1990. 2 fig, 4 tab, 15 ref.

Descriptors: \*Chemical analysis, \*Chlorinated hydrocarbons, \*Gas chromatography, \*Measuring instruments, \*Pesticides, \*Pollutant identification, \*Polychlorinated biphenyls, \*Water analysis, Data acquisition, Performance evaluation.

The lack of confirmation of identified analytes in environmental gas chromatography (GC) that uses the traditional one-column, one detector systems (e.g., GC-electron capture detection with a nonpolar column) often raises questions as to the validity of the data. To avoid misidentification of chlorinated pesticides and polychlorinated biphenyls (PCB), simultaneous dual-column, dual-detector GC analysis was conducted. Within one GC instrument, injected sample extracts were split in two and each portion passed through a capillary column of different polarity. A traditional nonpolar column, DB-5, was connected to an electron capture detector for initial identification of analytes; a more polar column DB-17, was used with the halogen specific electrolytic conductivity detector for confirmation analysis. GC column retention characteristics were determined for a large set of environmentally important pesticides and PCB congeners for the DB-5 and DB-17 analytical columns. The dual-column, dual-detector system was then evaluated on a large number of environmental samples of different matrix types. Results indicated that a substantial number of analytes, especially pesticides, may be incorrectly identified in environmental samples with one-column, one-detector systems. Use of a simultaneous dual-column, dual-detector system, substantially decreases the risk of false positive identifications without significantly increasing the cost at time of analysis. (Author's abstract) W91-01281

**EFFECTS OF SALINITY, TEMPERATURE, AND CADMIUM ON CADMIUM-BINDING PROTEIN IN THE GRASS SHRIMP, PALAEMONETES PUGIO.** Texas Univ. Health Science Center at Houston. School of Public Health. For primary bibliographic entry see Field 5B. W91-01309

**LONG-TERM TOXICITY TEST COMPRISING REPRODUCTION AND GROWTH OF ZEBRA-FISH WITH 4-CHLOROANILINE.**

Bundesforschungsanstalt fuer Ernährung, Karlsruhe (Germany, F.R.). For primary bibliographic entry see Field 5C. W91-01318

**INCORPORATION OF A SUBACUTE TEST WITH ZEBRA FISH INTO A HIERARCHICAL SYSTEM FOR EVALUATING THE EFFECT OF TOXICANTS IN THE AQUATIC ENVIRONMENT.** Swedish Environmental Research Inst., Stockholm. For primary bibliographic entry see Field 5C. W91-01327

**ADVANCES IN ESTIMATING BACTERIAL BIOMASS AND GROWTH IN AQUATIC SYSTEMS.** Vandkvalitetsinstitutet, Hoersholm (Denmark). B. Riemann, and R. T. Bell. Archiv fuer Hydrobiologie AHYBA4, Vol. 118, No. 4, p 385-402, June 1990. 6 fig, 70 ref. Danish EPA (NPO 4.6), Danish Nat. Sci. Res. Council (J.No. 11-5573) and the Swedish Nat. Sci. Res. Council (B-Bu 9170-300).

Descriptors: \*Aquatic bacteria, \*Bacterial analysis, \*Bacterial growth, \*Biomass, \*Limnology, \*Water analysis, Calibrations, Estimating, Growth rates, Nucleic acids, Testing procedures.

A review of the methods designed to measure growth rates of natural bacterial assemblages is presented. In addition, problems in sizing bacteria and determining bacterial carbon biomass are considered. A large number of techniques are now available to determine growth rates of natural bacterial assemblages. <sup>3</sup>H-thymidine incorporation and <sup>3</sup>H-adenine incorporation into DNA and <sup>3</sup>H-leucine incorporation into protein are currently in use in many laboratories. When properly calibrated these methods can give reasonable estimates of bacterial growth rates. The leucine and thymidine methods together will give the best assessment of bacterial growth rates and information on their physiological status. Adenine incorporation requires size fractionation of environmental samples if used to measure only bacterial growth. When adenine is used together with thymidine, an index of both algal and bacterial DNA synthesis can be obtained. The use of the frequency of dividing cells (FDC) procedure often overestimates bacterial carbon production compared to results obtained from other techniques. It was found that many of the methods are complementary when compared over proper time scales, but continued calibrations and validations of the methods are still needed when environmental samples are examined for growth of bacteria. (Author's abstract) W91-01334

**MOST DILUTE LAKE IN THE WORLD.** E and S Environmental Chemistry, Inc., Corvallis, OR. For primary bibliographic entry see Field 2H. W91-01348

**ACCUMULATION OF SCANDIUM IN THE SHOOTS OF AQUATIC BRYOPHYTES IN ACID WATER.** National Inst. for Environmental Studies, Ibaraki (Japan). For primary bibliographic entry see Field 2H. W91-01355

**PHARMACOKINETIC MODELING IN AQUATIC ANIMALS. I. MODELS AND CONCEPTS.** Dow Chemical Co., Midland, MI. Environmental Toxicology and Chemistry Research Lab. M. G. Barron, G. R. Stehly, and W. L. Hayton. Aquatic Toxicology AQTOG, Vol. 17, No. 3, p 187-211, September 1990. 3 fig, 2 tab, 70 ref.

Descriptors: \*Bioindicators, \*Data interpretation, \*Literature review, \*Model studies, \*Pharmacokinetics

## Identification Of Pollutants—Group 5A

kinetics, \*Toxicology, \*Water pollution effects, Mathematical models, Mathematical studies.

While clinical and toxicological applications of pharmacokinetics have continued to evolve both conceptually and experimentally, pharmacokinetic modeling in aquatic animals has not progressed accordingly. Several methods and concepts are presented in this literature review of pharmacokinetic modeling in aquatic animals using multicompartmental, clearance-based, non-compartmental and physiologically-based pharmacokinetic models. These models should be considered as alternatives to traditional approaches, which assume that the animal acts as a single homogeneous compartment based on apparent monoexponential elimination. Multicompartmental models are a necessary increase in complexity when elimination is biphasic, or when there is a widely different distribution between high perfusion and low perfusion tissues. Alternatives to traditional rate constant based models are clearance-based compartmental models, which have parameters that may be interpreted in terms of the controlling physiological and biochemical processes. Non-compartmental methods characterize uptake, distribution, elimination, and persistence without making assumptions about the underlying model topology. The development of physiologically based models is highly desirable because they allow extrapolation to other species, body sizes and environmental conditions. (Author's abstract)

W91-01361

#### FISH HEALTH AND ENVIRONMENTAL HEALTH.

National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.

For primary bibliographic entry see Field 5C.  
W91-01376

#### AUTOTROPHIC AND HETEROTROPHIC ATP POOLS IN MICROBIAL COMMUNITIES: SUGGESTIONS FOR SEPARATION AND FOR BACTERIAL GROWTH RATE EVALUATION.

Parma Univ. (Italy). Ist. di Ecologia.  
R. Antonietti.

Ergebnisse der Limnologie ERLIA6, Vol. 34, p 75-80, 1990. 6 fig, 11 ref.

Descriptors: \*Adenosine triphosphate, \*Aquatic bacteria, \*Bacterial physiology, \*Microbiological studies, \*Separation techniques, \*Toxicity, \*Water pollution effects, \*Water quality monitoring, Algae, Analytical methods, Bacterial analysis, Bioassay, Biomass, Inhibitors, Mathematical models.

The measurement of adenosine triphosphate (ATP) was utilized as a speedy, sensitive, precise and accurate indicator of bacterial biomass changes. Some substances (sodium and potassium hydroxides, potassium cyanide, hydrogen peroxide and sodium azide) were found to decrease bacterial ATP pools within a few seconds. The effects were not observed for *Chlorococcus* sp., *Selenastrum* sp. and *Scenedesmus* sp. If this behavior is confirmed in all algae, then it will be possible to define the bacterial/algal ATP ratio. The bacterial growth rate could then be evaluated using ATP as a biomass index in a simple mathematical model. It is probable that the physiological response to toxic substances depends not so much on the trophic level of microorganisms as on multiple factors such as the biochemical and physiological structure of the microbial community and the complexity of cell/detritus aggregates. Further study of the effects of toxic substances on a wider spectrum of microorganisms, especially Cyanobacteria, is recommended. (MacKeen-PTT)

W91-01595

#### ECOLOGICAL ASPECTS OF ENZYME REGULATION IN AQUATIC BACTERIA.

Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Abt. Mikrobiologie.

For primary bibliographic entry see Field 2H.  
W91-01596

#### ANALYSIS OF 228RA AND 226RA IN PUBLIC WATER SUPPLIES BY A GAMMA-RAY SPECTROMETER.

Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.  
B. Kahn, R. Rosson, and J. Cantrell.  
Health Physics HLTPAO, Vol. 59, No. 1, p 125-131, July 1990. 2 fig, 5 tab, 20 ref. EPA Grant CR-813-630-01.

Descriptors: \*Data interpretation, \*Pollutant identification, \*Radon radioisotopes, \*Spectrometry, \*Water analysis, \*Water supply, Detection limits, Public waters, Radioactivity, Water quality standards.

Methods for measuring 228Ra were reviewed to select a brief and simple screening procedure under the National Interim Primary Drinking Water Regulations for public water supplies. A two-step method was considered to concentrate Ra by evaporation or co-precipitation and to count it with a gas ionization detector, a liquid-scintillation detector, or a Ge detector with multichannel analyzer. Gross beta particle counting appears to be feasible for screening to meet the 0.04 Bq/L detection limit. The same sample volume can be utilized to measure radiation with commonly available equipment in reasonable time. The required sample volumes were estimated on the basis of known counting efficiencies and background count rates. Gamma-ray spectral analysis is the recommended option, however, because 226Ra and 228Ra can be determined directly and simultaneously. Several aspects of the method were examined to assure that the concentration procedure is nearly quantitative and that the detection limit can be reached with a 3.8 L sample in a 6000 s counting period. The method was tested with Ra tracer solutions and EPA intercomparison samples over the range of 0.04 to 1 Bq/L. It was found appropriate for 228Ra and 226Ra analyses. (Author's abstract)

W91-01667

#### INDUCTION OF ALKOXYRESORUFIN METABOLISM: A POTENTIAL INDICATOR OF ENVIRONMENTAL CONTAMINATION.

Barcelona Univ. (Spain). Dept. of Microbiology.  
For primary bibliographic entry see Field 5C.  
W91-01685

#### CHARACTERIZATION OF GENOTOXIC COMPONENTS IN SEDIMENTS BY MASS SPECTROMETRIC TECHNIQUES COMBINED WITH SALMONELLA/MICROSOME TEST.

Barcelona Univ. (Spain). Dept. of Microbiology.  
M. Grifoll, A. M. Solanas, and J. M. Bayona.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 2, p 175-184, March/April 1990. 4 fig, 3 tab, 31 ref.

Descriptors: \*Bioassay, \*Genotoxicity, \*Mass spectrometry, \*Pollutant identification, \*Polycyclic aromatic hydrocarbons, \*Sediment contamination, \*Toxicology, Anhydrides, Aromatic compounds, Azarenes, Barcelona, Biological studies, Chemical analysis, Gas chromatography, Ketones, River sediments, Salmonella/microsome test, Spain.

The application of Salmonella/microsomal mammalian tests to column chromatography fractions isolated from river and marine sediments collected in the vicinity of Barcelona city, Spain, demonstrated a positive response (TA98+S9 mix) among the polar fractions. Chemical analysis by high resolution gas chromatography coupled to negative ion chemical ionization mass spectrometry (HRGC-NICI MS) provided sensitivity and selectivity to detect several mutagenic chemical classes. Among them, nitrated PAHs, azarenes, aromatic amines, anhydrides, and ketones were identified. A total of 116 compounds were tentatively identified, 22 for the first time, of which 16 possessed mutagenic activity. However, a lack of correlation between chemical composition and fraction mutagenicity in the medium polarity fractions, especially in the river sediment, was evidenced. The occurrence of multiple interactions between components in spiked organic extracts is demonstrated. (Author's abstract)

W91-01686

#### USE OF THE MUSSEL WATCH AND MOLECULAR MARKER CONCEPTS IN STUDIES OF HYDROCARBONS IN A TROPICAL BAY (TODOS OS SANTOS, BAHIA, BRAZIL).

Centro de Investigacion y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry.  
C. Porte, D. Barcelo, T. M. Tavares, V. C. Rocha, and J. Albaiges.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 2, p 263-274, March/April 1990. 7 fig, 3 tab, 51 ref.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Brazil, \*Hydrocarbons, \*Mussels, \*Path of pollutants, \*Pollutant identification, \*Todos os Santos Bay, \*Tropical regions, \*Water quality, Alkylbenzene, Bays, Monitoring.

Data on aliphatic and aromatic hydrocarbons in different species of edible bivalves collected from the Todos os Santos Bay (Bahia, Brazil) are reported on for the first time along the Southwest Atlantic coast. The species and collection sites were selected for the identification of suitable regional sentinels and for the assessment of different coastal pollutant sources. To this end, the molecular marker concept was applied. A new series of biogenic 20C, 25C, and 30C highly branched isoprenoid alkenes were present in clean samples. Long-chain alkylbenzenes and specific distributions of terpenoids, steranes, and hopanes reflected local industrial activities. Petrogenic alkanes and aromatic hydrocarbons, ranged between 0.1-42 micrograms/L wet wt and 0.1-9.1 micrograms eq chrysene/g wet wt, respectively, the higher levels being found in the neighborhood of an oil refinery and a plant oil industrial plant. Anomalous brasiliana, the dominant and most frequent bivalve of the Brazilian coast, was found to be an adequate bioindicator because it accumulates organic pollutants with reasonable sensitivity. (Author's abstract)

W91-01690

#### GC-MS IDENTIFICATION OF GASEOUS VOLATILES IN WASTEWATER.

National Univ. of Singapore. Dept. of Civil Engineering.

L. C. C. Koe, and N. C. Tan.

Environmental Monitoring and Assessment EMASDH, Vol. 15, No. 1, p 13-24, July 1990. 4 fig, 5 tab, 8 ref.

Descriptors: \*Chemical analysis, \*Gas chromatography, \*Mass spectrometry, \*Pollutant identification, \*Volatile organic compounds, \*Wastewater, \*Water analysis, Aeration, Air stripping, Chlorinated hydrocarbons, Hydrocarbons, Organic acids, Phenols, Sulfides.

Gaseous volatiles from wastewater samples taken from a local sewage treatment plant were air stripped and trapped onto Tenax GC. These volatiles were then thermally desorbed and subsequently analyzed using gas chromatography coupled to a mass spectrometer (GC-MS). The results show that saturated aliphatic and aromatic hydrocarbons were the most dominant compounds found in the sewage gaseous volatiles. Other compounds found were chlorinated hydrocarbons, organic acids, sulfides and phenols. A wide variety of gaseous volatiles were found in the raw wastewater, the primary clarifier effluent, the pre-aeration wastewater and the sludge samples. A comparison of the gas chromatograms for the pre and post-aeration wastewater shows that many odorous gaseous volatiles were removed during the aeration process in the treatment plant. (Author's abstract)

W91-01696

#### RELATIONSHIP BETWEEN WATER QUALITY AND CADDISFLY ASSEMBLAGE STRUCTURE IN FAST-RUNNING RIVERS. THE RIVER CADAGUA BASIN.

Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.

A. Basaguren, and E. Orive.

Environmental Monitoring and Assessment

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5A—Identification Of Pollutants

EMASDH, Vol. 15, No. 1, p 35-48, July 1990. 4 fig, 5 tab, 31 ref.

Descriptors: \*Bioindicators, \*Cadagua River, \*Caddisflies, \*Ecosystems, \*Spain, \*Species diversity, \*Water pollution effects, \*Water quality, Headwaters, Oxygen, Species composition.

Water quality effects were studied in of the River Cadagua basin in Spain, using trichopteran taxa as indicators. Differences between headwater reaches and lower parts of the main river and its principal tributaries are chiefly based on the downstream substitution of the species of the genus *Rhyacophila* by species of the genus *Hydropsyche*. The first station of the Cadagua River is separated from other headwater sites by the presence of a trichopteran assemblage composed of *Rhyacophila tristis*, *Lype reducta* and *Tinodes assimilis*. Sympatric species of the genera *Rhyacophila* and *Hydropsyche* coexist at several places, although appear alone at other sites, and show differential preferences for the highest or the lowest sites. Thus, *Hydropsyche pellucidula* coexisted with *Hydropsyche siltalai* in the middle section of the rivers, but the former was distributed further downstream than the latter which occupied higher reaches. Among sites, differences in trichopteran assemblage structure are a result of both natural and anthropogenic changes in the physicochemical features of the watercourse. Therefore, trichopteran diversity and coexistence of sympatric species increase downstream with increasing nutrient values (whether the oxygen content of the water is near the saturation level). However, Trichoptera disappear from sites with low oxygen content. Conductivity values do not seem to affect the trichopteran distribution in natural waters, as values higher than 700 microS/cm were found at the head water of the main river which contained an assemblage characteristic of these sites. (Author's abstract)  
W91-01697

**TRIAZINE HERBICIDE FATE IN A NO-TILLAGE CORN (ZEA MAYS L.)-CROWNVECH (CORONILLA VARIA L.) LIVING MULCH SYSTEM.**  
Pennsylvania State Univ., University Park. Dept. of Agronomy.  
For primary bibliographic entry see Field 5B.  
W91-01709

**EXCHANGEABLE IMMOBILIZED ENZYME REACTOR FOR ENZYME INHIBITION TESTS IN FLOW-INJECTION ANALYSIS USING A MAGNETIC DEVICE. DETERMINATION OF PESTICIDES IN DRINKING WATER.**  
Gesellschaft fuer Biotechnologische Forschung m.b.H., Brunswick (Germany, F.R.). Dept. of Enzyme Technology.  
R. Kindervater, W. Kunnecke, and R. D. Schmid.  
Analytica Chimica Acta ACACAM, Vol. 234, No. 1, p 113-117, July 1990. 5 fig, 17 ref.

Descriptors: \*Analytical methods, \*Drinking water, \*Enzymes, \*Flow-injection analysis, \*Pesticides, \*Pollutant identification, \*Water analysis, Acetylcholinesterase, Carbofuran, Enzyme inhibition testing, Malaoxon, Water quality management.

A flow-injection system for rapid automated enzyme inhibition testing was developed using magnetic particles as the enzyme support. Exchange of inactivated enzyme immobilized on magnetic particles was performed with magnetic devices which could be electrically switched off to release all bound material. The flow resistance of the reactor was excellent. Inhibition of immobilized acetylcholinesterase (ACHE) was used to determine pesticides in drinking water. Concentrations of 0.5 microgram/L of the pesticides carbofuran and malaoxon were detected. A complete cycle of analysis, including calibration, took 20 min. The sensitivity of this assay is excellent and covers the demands for European drinking water analysis, although the detection limit has not yet been optimized. However, as the contamination of drinking water is expressed as the amount of pesticide and not as the toxicity against ACHE, the proposed method is a good alternative to non-biological standard methods such as gas chroma-

tography and liquid chromatography. (Agostine-PTT)  
W91-01710

**ON-LINE CONTINUOUS-FLOW EXTRACTION SYSTEM IN LIQUID CHROMATOGRAPHY WITH ULTRAVIOLET AND MASS SPECTROMETRIC DETECTION FOR THE DETERMINATION OF SELECTED ORGANIC POLLUTANTS.**  
Universitat Politècnica de Catalunya, Barcelona (Spain). Dept. of Chemical Engineering.  
A. Farran, J. L. Cortina, J. De Pablo, and D. Barcelo.  
Analytica Chimica Acta ACACAM, Vol. 234, No. 1, p 119-126, July 1990. 6 fig, 1 tab, 23 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Liquid chromatography, \*Mass spectrometry, \*Organic pollutants, \*Pesticides, \*Pollutant identification, \*Spectrometry, \*Water analysis, Organophosphorus compounds, Surface water.

An on-line extraction system with completely continuous-flow analysis prior to the liquid chromatographic (LC) column was used for the determination of the organophosphorus pesticides tetrachlorvinphos and parathion-methyl and their degradation products 2,4,5-trichlorophenol and 4-nitrophenol, respectively, and the chlorinated phenoxy acids 2,4-D, 2,4,5-T and silvex in water samples. The extent of extraction varied from 100% for chlorinated phenoxy acids to 60% for organophosphorus pesticides and 2,4,5-trichlorophenol. The extraction of 4-nitrophenol was less than 10% under these conditions. By employing positive-ion mode thermospray LC-mass spectrometry, the characterization of tetrachlorvinphos was feasible, indicating (M + NH<sub>4</sub>)(+) as the base peak and a second peak with 20% relative intensity corresponding to (M + H)(+). When the negative-ion mode was used, the chlorinated phenoxy acids and 2,4,5-trichlorophenol exhibited (M + HCOO)(-) as the base peak and a second peak with 30% relative intensity corresponding to (M-H)(-). Enrichment factors of almost one order of magnitude have been achieved for model compounds in water samples. These enrichment factors using liquid-liquid extraction are lower than those obtained with on-line precolumn systems using solid adsorbents, but there are less memory effects. This system allows the ultraviolet detection and mass spectrometer characterization of low-nanogram levels of pesticide residues in river water samples. (Author's abstract)  
W91-01711

**DETECTION OF ORGANIC TOXIC POLLUTANTS IN WATER AND WASTE-WATER BY LIQUID CHROMATOGRAPHY AND IN VITRO CYTOTOXICITY TESTS.**  
Instituto Nacional de Investigaciones Agrarias, Madrid (Spain). Centro de Investigacion y Tecnologia.  
J. V. Tarazona, A. Castano, and B. Gallego.  
Analytica Chimica Acta ACACAM, Vol. 234, No. 1, p 193-197, July 1990. 6 fig, 12 ref.

Descriptors: \*Bioassay, \*Cytology, \*Liquid chromatography, \*Organic pollutants, \*Pollutant identification, \*Surface water, \*Toxicology, \*Wastewater, Analytical methods, Effluents, Fish, Industrial wastes, Trout.

A group of toxicity tests on RTG-2 cell line (a fibroblastic line derived from rainbow trout) was standardized in order to enhance reproducibility and sensitivity. Liquid chromatographic (LC) separation of organic chemicals from industrial effluents and polluted waters and in vitro toxicity tests on RTG-2 as a biological detector of toxicity in the eluted peaks were conducted. Effluents and polluted waters were concentrated, if required, using Sep-Pak C-18 cartridges, and analyzed by reversed-phase LC using a 30-cm C-18 column with an acetonitrile gradient from 10 to 100% in water in 60 min at a flow-rate of 1 mL/min and UV detection at 254 and 280 nm. The cytotoxicity test was adapted to use 20-microliter fractions of acetonitrile-water mixtures, allowing toxicity detection every 12 s with eight replicates per sample

(or every 5 s with four replicates). The LC-cytotoxicity test combination allowed the detection in the effluents of those compounds for which short-term aquatic toxicity could be expected. Cytotoxicity to fish cell lines was found to be fairly well correlated with in vivo toxicity tests on fish, showing the capability of this method. The correlation between in vivo and in vitro methods has also been demonstrated in mammalian cells, and therefore this method is useful not only in aquatic toxicology but also, by choosing a representative cell line, in environmental, clinical or forensic toxicology. (Author's abstract)  
W91-01712

**AUTOMATED METHOD FOR THE DETERMINATION OF BORON IN WATER BY FLOW-INJECTION ANALYSIS WITH IN-LINE PRE-CONCENTRATION AND SPECTROPHOTOMETRIC DETECTION.**  
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.  
I. Sekerka, and J. F. Lechner.  
Analytica Chimica Acta ACACAM, Vol. 234, No. 1, p 199-206, July 1990. 6 fig, 5 tab, 33 ref.

Descriptors: \*Analytical methods, \*Boron, \*Chemical analysis, \*Pollutant identification, \*Spectrophotometry, \*Water analysis, Emission spectrometry, Ion exchange, Monitoring, Natural waters.

A sensitive, automated method for the determination of boron in water samples is described, involving flow injection with on-line ion-exchange pre-concentration and spectrophotometric detection of the azomethine-H-boron complex. The method is applicable to various water samples and is free from interferences, even in colored samples. Detection limits of 5 microgram/L at 20 samples/h and 1 microgram/L at 10 samples/h with relative standard deviations of < 10% at 1-10 microgram/L and < 5% at 10-200 microgram/L levels of boron were achieved. The recoveries for spiked natural water samples ranged from 96 to 101%. The method compares favorably with inductively coupled plasma atomic emission spectrometry. (Author's abstract)  
W91-01713

**LIQUID CHROMATOGRAPHIC METHOD WITH FLUORESCENCE DETECTION FOR THE DETERMINATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN ENVIRONMENTAL SAMPLES.**  
Laboratorio Municipal de Barcelona (Spain). Seccion Quimica y Bromatologia.  
M. D. Nunez, and F. Centrich.  
Analytica Chimica Acta ACACAM, Vol. 234, No. 1, p 269-273, July 1990. 6 fig, 3 tab, 11 ref.

Descriptors: \*Chemical analysis, \*Fluorescence, \*Hydrocarbons, \*Liquid chromatography, \*Pollutant identification, \*Polycyclic aromatic hydrocarbons, \*Water analysis, Analytical methods, Extraction techniques.

A method using liquid chromatography (LC) with fluorimetric detection for the determination of polynuclear aromatic hydrocarbons (PAHs) in water samples and air filters is presented. The study focused on fluoranthene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene and benzo(ghi)perylene. The behavior of these compounds was studied using two columns with the same stationary phase (C-18), but different supports, Hypersil-ODS and Spherisorb ODS-2. Better resolution was obtained with Spherisorb ODS-2. Samples were extracted with light petroleum-diethyl ether (85 + 15) and the extracts were concentrated before analysis. Reversed-phase liquid chromatography with fluorescence detection was applied to separate and determine the PAHs. Recoveries of individual PAHs from spiked water samples were 0.16-0.27 ng/mL. Detection limits in the picogram range were obtained for each compound based on recoveries of 79-96% from the water matrix. (Agostine-PTT)  
W91-01714

## Identification Of Pollutants—Group 5A

**EXAMINATION OF THE RANGE OF COPPER COMPLEXING LIGANDS IN NATURAL WATERS USING A COMBINATION OF CATHODIC STRIPPING VOLTAMMETRY AND COMPUTER SIMULATION.**

Water Research Centre, Medmenham (England).  
Medmenham Lab.  
For primary bibliographic entry see Field 5B.  
W91-01715

**SPECIATION OF MERCURY COMPOUNDS IN WASTE WATER BY MICROCOLUMN LIQUID CHROMATOGRAPHY USING A PRECONCENTRATION COLUMN WITH COLD-VAPOR ATOMIC ABSORPTION SPECTROMETRIC DETECTION.**

Nagoya Univ. (Japan). Dept. of Applied Chemistry.  
E. Munaf, H. Haraguchi, D. Ishii, T. Takeuchi, and M. Goto.  
Analytica Chimica Acta ACACAM, Vol. 235, No. 2, p 399-404, August 15, 1990. 6 fig, 1 tab, 26 ref.

Descriptors: \*Atomic absorption spectrophotometry, \*Chemical analysis, \*Heavy metals, \*Liquid chromatography, \*Mercury, \*Pollutant identification, \*Speciation, \*Wastewater analysis, Analytical methods, Mercury compounds, Wastewater.

A microcolumn liquid chromatographic method with cold-vapor atomic absorption spectrometric detection was developed for the speciation of mercury compounds in wastewater. The sample solution containing mercury at the 4-ng level was injected into a preconcentration column (27 mm x 0.51 mm i.d.) packed with Develosil-ODS (30 micrometer) and eluted with cysteine-acetic acid through a separation column (125 mm x 0.5 mm i.d.) packed with STR-ods-H 95 micrometer. After oxidation, tin (II) chloride in sodium hydroxide solution was used to reduce mercury compounds to mercury. The generated mercury vapor was swept from a gas-liquid separator by argon into the detector cell and monitored at 253.7 nm. Mercury (II) chloride, methylmercury chloride and ethylmercury chloride, were well resolved and the determination was completed in less than 16 min. The method was successfully applied to the speciation of mercury compounds in wastewater. (Author's abstract)  
W91-01716

**FATE OF CATIONIC SURFACTANTS IN THE MARINE ENVIRONMENT. I. BIOCONCENTRATION OF LONG-CHAIN ALKYLNITRILES AND TRIALKYLAMINES.**

Centro de Investigación y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry.  
For primary bibliographic entry see Field 5B.  
W91-01723

**ANALYSIS OF TARGET AND NONTARGET POLLUTANTS IN AQUEOUS LEACHATES FROM THE HAZARDOUS WASTE SITE IN STRINGFELLOW, CALIFORNIA, VIA ION CHROMATOGRAPHY-PARTICLE BEAM AND INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY.**

California Dept. of Health Services, Berkeley. Hazardous Materials Lab. Section.  
M. A. Brown, I. S. Kim, R. Roehl, F. I. Sasinos, and R. D. Stephens.  
Chemosphere CMSHAF, Vol. 19, No. 12, p 1921-1927, 1989. 2 fig, 16 ref.

Descriptors: \*Analytical methods, \*California, \*Chemical analysis, \*Hazardous wastes, \*Leachates, \*Mass spectrometry, \*Pollutant identification, \*Water analysis, Chlorine, Halogens, Ion exchange chromatography, Organic pollutants, Phosphorus, Sulfur.

Liquid chromatography particle beam mass spectrometry (PB/MS) is a powerful tool for the analysis of target pollutants but complementary methods are required for nontarget compounds. Preliminary data are presented on an anion exchange chromatography PB/MS based method for the detection of the target compound 4-chlorobenzene sulfonic acid (a contaminant found in hazardous waste leachates) and also for nontarget pollutants in aqueous leachate samples from the Stringfellow hazardous waste site in California. Anion exchange chromatography coupled to inductively coupled plasma mass spectrometry yields qualitative and quantitative elemental analysis showing the presence or absence of key heteroatoms in organic pollutants including chlorine, other halogens, phosphorus and sulfur. (Author's abstract)  
W91-01728

**POLYNUCLEAR AROMATIC HYDROCARBON (PAH) CONTENT OF ARCHIVED SEWAGE SLUDGES.**

Lancaster Univ. (England). Inst. of Environmental and Biological Sciences.  
S. R. Wild, S. P. McGrath, and K. C. Jones.  
Chemosphere CMSHAF, Vol. 20, No. 6, p 703-716, 1990. 3 fig, 5 tab, 29 ref.

Descriptors: \*Path of pollutants, \*Polycyclic aromatic hydrocarbons, \*Sludge analysis, \*Sludge utilization, \*Waste disposal, \*Wastewater, Agriculture, Hydrocarbons, Land disposal, Sludge.

Twenty-nine anaerobically digested, lagoon dried sewage sludges were analyzed for polynuclear aromatic hydrocarbons (PAHs). These sludges had been applied to the plots of a long term agricultural experiment from 1942 to 1961. The exact dates of sludge production and treatment are unknown, although they are likely to be 1-5 years prior to sludge application dates. The sludges had a mean Sum-PAH (defined as the sum of the compounds measured) concentration of 50 mg/kg, with a range of 18-125 mg/kg. The most abundant compound was benzo(ghi)perylene with a mean concentration of 10 mg/kg. A trend is apparent in the Sum-PAH content through time, increasing until 1948 to over 125 mg/kg, then decreasing to 29 mg/kg by 1961. These changes are tentatively attributed to changes in air quality and smoke emissions. The PAH content of contemporary sludges is also reviewed. There is little evidence to suggest that the PAH abundance in the London area has changed significantly from the 1960's to the present day. (Author's abstract)  
W91-01737

**ISOLATION AND CHARACTERIZATION OF HEPATOTOXIC MICROCYSTIN HOMOLOGS FROM THE FILAMENTOUS FRESHWATER CYANOBACTERIUM NOSTOC SP. STRAIN 152.**

Helsinki Univ. (Finland). Dept. of Microbiology.  
For primary bibliographic entry see Field 2H.  
W91-01761

**FAILURE OF A DIAGNOSTIC MONOCLONAL IMMUNOFLOUORESCENT REAGENT TO DETECT LEGIONELLA PNEUMOPHILA IN ENVIRONMENTAL SAMPLES.**

Veterans Administration Medical Center, Pittsburgh, PA. Special Pathogens Section.  
R. M. Vickers, J. E. Stout, and V. L. Yu.  
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 9, p 2912-2914, September 1990. 1 tab, 10 ref.

Descriptors: \*Fluorescence, \*Hospitals, \*Immunocassay, \*Legionella, \*Pathogenic bacteria, \*Pollutant identification, Human pathogens, Potable water, Water distribution.

Three commercial diagnostic fluorescein-labeled antibodies, one monoclonal and two polyclonal, were compared to evaluate their abilities to detect Legionella pneumophila in environmental samples collected from 4 hospitals, one nursing home, and one industrial plant. The samples were taken from 9 hot and cold storage tank waters, three swabs from two showers and 1 faucet. The monoclonal conjugate failed to detect L. pneumophila in the 12 environmental samples studied by direct immunofluorescence. In contrast, the two polyclonal conjugates detected L. pneumophila in all 12 samples by both direct and indirect immunofluorescence. However, isolates recovered by culture from the 12 samples demonstrated equal immunofluorescence with all three conjugates. The reason for the

failure of the monoclonal antibody to detect L. pneumophila in the environmental samples remains unknown. Laboratories considering the use of the monoclonal conjugate to screen environmental samples for L. pneumophila should be aware of this finding. (Author's abstract)  
W91-01764

**IMPROVED DETECTION OF ACID MINE WATER STRESSED COLIFORM BACTERIA ON MEDIA CONTAINING CATALASE AND SODIUM PYRUVATE.**

West Virginia Univ., Morgantown. Div. of Plant and Soil Sciences.  
J. P. Calabrese, and G. K. Bissonnette.  
Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 8, p 544-550, August 1990. 2 fig, 4 tab, 37 ref.

Descriptors: \*Acid mine drainage, \*Coliforms, \*Culture media, \*Escherichia coli, \*Pollutant identification, \*Water pollution effects, Bioindicators, Culturing techniques, Enzymes, Heterotrophic bacteria, Membrane filters.

Pure culture suspensions of two strains of exponential and stationary phase Escherichia coli exhibited significant reductions in catalase activity following exposure to acid mine water (AMW). The exogenous addition of catalase (500-2000 U) or sodium pyruvate (0.05-5%) to a nonselective recovery medium resulted in enhanced detection (12- to 465-fold) of AMW-stressed E. coli as compared with recovery on the medium lacking these supplements, whereas addition of 3,3'-thiodipropionic acid failed to improve recovery. Additional in vitro experiments utilizing selective M-FC, mTT, and M-Endo media containing 1000 U catalase or 1.0% pyruvate similarly resulted in improved detection of AMW-stressed cells, with the exception of M-Endo containing pyruvate. Appropriately modified media were then used to analyze an AMW-impacted stream by the membrane filtration technique. Addition of catalase, pyruvate, or a combination of both significantly improved recovery of fecal and total coliforms without promoting growth of noncoliforms. Supplementation of plate count agar with pyruvate and/or catalase enhanced detection of total heterotrophs. These findings suggest that addition of catalase or pyruvate to standard recovery media may improve detection of coliform and total heterotrophic bacteria in AMW-impacted waters. (Author's abstract)  
W91-01770

**INDICATORS OF CHEMICAL POLLUTION FROM SEPTIC SYSTEMS.**

Geraghty and Miller, Inc., Raleigh, NC.  
B. J. Alhajjar, G. Chesters, and J. M. Harkin.  
Ground Water GRWAAP, Vol. 28, No. 4, p 559-568, July/August 1990. 5 fig, 2 tab, 49 ref.

Descriptors: \*Chlorides, \*Conductivity, \*Detergents, \*Fluorescence, \*Groundwater pollution, \*Hydrogen ion concentration, \*Pollutant identification, \*Septic tanks, \*Septic wastewater, \*Water pollution sources, Effluents, Nitrates, Statistical methods, Water chemistry.

The median-polish statistical method was used to test and quantify chloride, electrical conductivity, pH and fluorescence of laundry detergent optical brighteners as indicators of groundwater pollution from septic systems. The septic systems were located in coarse-textured soils over a high water table close to discharge areas in south-central Wisconsin. Parameters were measured monthly for two years in septic tank effluent samples and in water samples collected downgradient from 17 septic systems and from upgradient background samples. The median-polish technique was excellent for comparing hydrochemical data: chloride was a conservative tracer and the most suitable indicator of contaminant plumes, electrical conductivity was semiconservative and electrical conductivity and pH were only acceptable; and fluorescence was unacceptable. Fluorescence as an optical brightener in septic tank effluents ranged between 0.14 and 0.98 mg/L with an average value of 0.40 +/-0.16 mg/L. In groundwater downgra-

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### Group 5A—Identification Of Pollutants

dient from the septic systems, fluorescence levels were within the background levels. Natural substances such as humic and fulvic acids were probably the sources of fluorescence in groundwater, not optical brighteners, because optical brighteners did not pass through septic systems drainfields. Fluorescence of naturally occurring compounds in groundwater was between  $< 0.01$  and  $260 \text{ microg/L}$  with a mean of  $< 51 \pm 14 \text{ microg/L}$  expressed as optical brightener. Nitrification in the soil below the drainfields caused groundwater pH values to decrease within a few meters of the drainfields. (Author's abstract)  
W91-01785

**DETERMINATION OF TRACE QUANTITIES OF ORGANOTIN COMPOUNDS IN COASTAL WATERS OF GREECE BY GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY.**  
Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.  
K. Fytianos, and V. Samanidou.  
Science of the Total Environment STENDL, Vol. 92, p 265-268, March 1990. 1 tab, 12 ref.

Descriptors: \*Analytical techniques, \*Atomic absorption spectrophotometry, \*Coastal waters, \*Greece, \*Marinas, \*Organotin compounds, \*Spectral analysis, \*Tributyltin, \*Water pollution, \*Water pollution sources, Boats, Coastal environment, Coasts, Recreation facilities, Seasonal variation.

In recent years the growing use of antifouling paints containing organotin compounds of high toxicity has increased the possibility of pollution in areas of high pleasure-craft activity. The active biocides in these paints are bis(tributyltin) oxide (TBO) and tributyltin chloride (TBTCL). Where the density of boats is greatest and exchange with open water is least, water concentrations have consistently exceeded those known to be toxic to a variety of marine organisms. Samples of surface seawater from marinas in Greece were examined for the presence of tributyltin compounds. Samples were collected at 3-month intervals over a 1-year period from 1987-1988. Trace concentrations of tributyltin in seawater were determined by graphite furnace atomic adsorption spectrometry using preconcentration by extraction into toluene. Seasonal trends in contamination coincided with boat usage patterns and peaked during summer months. Concentrations of TBT in seawater dropped significantly with increasing distance from the marinas; TBT was below detection limit ( $< 5 \text{ ng/L}$ ) in the middle of Thessaloniki Gulf and in areas used for swimming. In Thessaloniki Harbor, the concentrations ranged between 25 and  $115 \text{ ng/L}$  and was clearly related to the high density of moorings and routes of major shipping traffic. The concentrations of organotin compounds in the examined areas were compared with those reported in the literature and are found to be similar to levels in slightly polluted areas. (Author's abstract)  
W91-01823

**EVALUATION OF DETENTION BASIN PERFORMANCE IN THE PIEDMONT REGION OF NORTH CAROLINA.**  
North Carolina Univ. at Charlotte. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5G.  
W91-01824

**TENTATIVE IDENTIFICATION OF ORGANIC COMPOUNDS AT THE WESTSIDE WASTEWATER TREATMENT PLANT (HIGH POINT, NC) AND IMPLICATIONS FOR AQUATIC TOXICITY.**  
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.  
For primary bibliographic entry see Field 5D.  
W91-01826

**SAMPLING STRATEGIES FOR PARAMETER ESTIMATION IN GROUNDWATER QUALITY MANAGEMENT: THEORY AND FIELD VALIDATION.**

California Univ., Los Angeles. Dept. of Civil Engineering.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-222258/AS. Price codes: A03 in paper copy, A01 in microfiche. Report UCLA-ENG-90-20, Feb 1990. 76p, 13 fig, 10 tab, 32 ref. USGS Contract No. 14-08-0001-G1499.

Descriptors: \*Experimental design, \*Field tests, \*Groundwater pollution, \*Optimization, \*Sampling, Algorithms, Groundwater management, Mathematical models, Parameter estimation, Planning, Tracers.

The report is divided into two parts. In part I, an optimal design algorithm is developed to facilitate the planning and the optimal configuration and scheduling of a groundwater tracer test whose data are to be used to estimate model parameters. A maximal information criterion is used to select among competing designs. A zero-one integer heuristic is used to solve a simplified example for experiment configurations under a given experimental duration. The design considers the installation cost which is a function of location and depth of the observation well, as well as the samples themselves. The resulting designs are intuitively reasonable. It was found that a dramatic increase in information can be obtained with an experimental budget increase in a heterogeneous example case. Part II of the report describes a two-well field test conducted to estimate the retardation of organic contaminants during transport in groundwater at the Borden site, Ontario, Canada. One inorganic tracer and four organic solutes were injected for a period of 48 hours and their migration towards the extraction well monitored by 3 multi-level and 1 partially penetrating monitoring wells. The results of this forced gradient field test are analyzed and compared with the results from a previous natural gradient experiment and associated laboratory studies of the aquifer media. (USGS)  
W91-01866

**ACID PRECIPITATION: BIOLOGICAL MONITORING OF STREAMS AND LAKES.**  
Bergen Univ. (Norway). Zoological Museum.  
A. Fjellheim, and G. G. Raddum.  
Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 57-66, July 1990. 3 fig, 1 tab, 29 ref.

Descriptors: \*Acid rain effects, \*Invertebrates, \*Monitoring, \*Norway, \*Water pollution effects, Acid streams, Benthic fauna, Buffer capacity, Fish-kill, Model studies, Precipitation, Salmon.

The activities and results from the Norwegian invertebrate acidification monitoring program are summarized. The program was started in 1981 and includes five watersheds. A key tool in the invertebrate monitoring program is a model which calculates an acidification index based on acid-sensitive invertebrates. The model is presented together with the acidification tolerances limits for different invertebrates. The results show that the degree of damage due to acidification differed over time and between watersheds. Generally, the watersheds in the southernmost parts of Norway were most acidified. In watersheds on the west coast, maximum acidification was measured in 1983 to 1984. This was correlated with episodic kills of young Atlantic salmon. During recent years, acidification has decreased in most rivers with the exception of those found in the southernmost regions. The rivers are, however, still vulnerable to acidification due to poor buffer capacity. (Author's abstract)  
W91-01890

**OCCURRENCE OF HEAVY METALS IN WATER, PHYTOPLANKTON, AND ZOOPLANKTON OF A MESOTROPHIC LAKE IN EASTERN POLAND.**  
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.  
For primary bibliographic entry see Field 5B.  
W91-01891

**POLYCLONAL AND MONOCLONAL ENZYME IMMUNOASSAYS FOR PICLORAM**

**DETECTION IN WATER, SOIL, PLANTS, AND URINE.**

Guelph Univ. (Ontario). Dept. of Environmental Biology.  
R. J. A. Deschamps, J. C. Hall, and M. R. McDermott.

Journal of Agricultural and Food Chemistry JAFCAU, Vol. 38, No. 9, p 1881-1886, September 1990. 1 fig, 7 tab, 17 ref.

Descriptors: \*Bioassay, \*Herbicides, \*Immunoassay, \*Pesticides, \*Picloram, \*Pollutant identification, Biological studies, Clopyralid, Fluroxypyr, Soil contamination, Triclopyr, Urine, Water pollution.

Two indirect enzyme immunoassays for picloram detection were compared in terms of sensitivity, accuracy and precision. The assay, using a rabbit antipicloram serum, had a linear working range from  $5000 \text{ ng/mL}$  with a mean  $501$  value of  $140 \text{ ng/mL}$  and a lower detection limit of  $5 \text{ ng/mL}$ . The assay, using a monoclonal antibody obtained from a mouse hybridoma cell line, yielded a linear working range from  $1$  to  $200 \text{ ng/mL}$  with a mean  $501$  value of  $10 \text{ ng/mL}$  and a lower detection limit of  $1 \text{ ng/mL}$ . Neither assay showed appreciable cross-reactivity with the structurally related pyridine herbicides clopyralid, fluroxypyr, and triclopyr or with the phenoxyacetic acid herbicide 2,4-D. From the analysis of fortified river water, soil extracts, plant extracts, and urine, the monoclonal antibody based assay was shown to be more sensitive, more accurate and more precise than the polyclonal antiserum based assay. Only the monoclonal assay was suitable for quantitative determination of picloram. (Author's abstract)  
W91-01912

**BROAD-RANGE METHODS FOR DETERMINATION OF POLLUTANTS IN WASTEWATER.**

Environmental Protection Agency, Washington, DC. Industrial Technology Div.  
W. A. Tellard.  
Journal of Chromatographic Science JCHSBZ, Vol. 28, No. 9, p 453-459, September 1990. 10 tab, 7 ref.

Descriptors: \*Chemical analysis, \*Laboratory methods, \*Organic compounds, \*Pollutant identification, \*Wastewater analysis, \*Water analysis, Atomic absorption spectrometry, Chlorinated hydrocarbons, Dioxins, Gas chromatography, Mass spectrometry, Metals.

The EPA is required by the Federal Water Pollution Control Act (FWPCA) and the Clean Water Act (CWA), and amendments thereto, to control or eliminate discharges of pollutants into waterways in the US, its territories and possessions. In controlling these discharges, the EPA's Industrial Technology Division (ITD) within the EPA's Office of Water Regulations and Standards (OWRS) has been given the responsibility of establishing effluent limits for any substance that may have an adverse effect on human health or the environment. The ITD determines the concentrations of pollutants at industrial plants in order to assess the performance of various water and waste treatment technologies. To determine the concentration of pollutants, ITD uses broad range analytical methods so that the largest number of pollutants can be measured at the lowest cost. At the same time, ITD must produce the most precise and accurate data possible so that the regulations most closely reflect the true value of the pollutants in wastewater. This paper gives technical details of Method nos. 1620, which surveys 69 elements using inductively coupled plasma spectrometry (ICP), graphite furnace atomic absorption spectrometry (GFAA), and cold vapor atomic absorption (CVAA); 1613, which measures the tetra-, through octa-, chlorinated dibenzo-p-dioxins (CDDs) and chlorinated dibenzofurans (CDFs) using high resolution gas chromatography/mass spectrometry (HRGC-HRMS); Method 1618, which measures herbicides, PCBs, and organochlorine and organophosphorus pesticides using GC; and Method 1624, which determines purgeable or-

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ganic compounds by calibrated isotope dilution or internal standard GC/MS. (Lantz-PTT)  
W91-01914

#### DETERMINATION OF VOLATILE ORGANICS IN DRINKING WATER WITH USEPA METHOD 524.2 AND THE ION TRAP DETECTOR.

Environmental Monitoring Systems Lab., Cincinnati, OH.  
For primary bibliographic entry see Field 5F.  
W91-01915

#### SUPERCritical FLUID EXTRACTION AND ITS APPLICATION TO ENVIRONMENTAL ANALYSIS.

Mid-Pacific Environmental Lab., Mountain View, CA.  
V. L. Avila, N. S. Dodhiwala, and W. F. Beckert.  
Journal of Chromatographic Science JCHSBZ, Vol. 28, No. 9, p 468-476, September 1990. 5 fig, 8 tab, 16 ref.

Descriptors: \*Chemical analysis, \*Chlorinated hydrocarbons, \*Organophosphorus pesticides, \*Pesticides, \*Pollutant identification, \*Supercritical gases, \*Water analysis, Aromatic hydrocarbons, Comparison studies, Laboratory methods.

Sand, spiked with 41 organochlorine pesticides and 47 organophosphorus pesticides, was extracted with supercritical carbon dioxide at various pressures and temperatures, and the recoveries were determined. Two standard reference materials certified for polynuclear aromatic hydrocarbons were extracted under supercritical conditions, and the data compared with the certified values which have been determined by conventional extraction techniques. There is a large discrepancy between the resulting data and the certified values. To explain the discrepancy, a preliminary optimization study was conducted in which the influences on recoveries of seven variables were investigated. The study allowed for the estimation of the main effects of the seven variables; however, the authors could not test the statistical significance of any of these effects. Results from the preliminary method optimization experiments indicate that under the conditions used, recovery is most effected by extraction time and extraction pressure, followed by moisture content of the material and sample size. The approximate costs associated with setting up and using a supercritical fluid extraction system in an analytical laboratory are presented and are compared with those for Soxhlet extraction. (Author's abstract)  
W91-01916

#### RAPID METHOD FOR THE SIMULTANEOUS ANALYSIS OF CHLORPYRIFOS, ISOFPENPHOS, CARBARYL, IPRODIONE, AND TRIADIMEFON IN GROUNDWATER BY SOLID-PHASE EXTRACTION.

Massachusetts Pesticide Analysis Lab., Amherst. M. W. Brooks, D. Tessier, D. Soderstrom, J. Jenkins, and J. M. Clark.  
Journal of Chromatographic Science JCHSBZ, Vol. 28, No. 9, p 487-489, September 1990. 3 fig, 2 tab, 7 ref.

Descriptors: \*Carbaryl, \*Chlorpyrifos, \*Groundwater pollution, \*Iprodione, \*Isofenphos, \*Laboratory methods, \*Pesticides, \*Pollutant identification, \*Triadimefon, Chemical analysis, Detection limits, Gas chromatography, Water analysis.

A method for the simultaneous analysis of pesticides in groundwater involves the extraction of the pesticides onto 18C columns and then elution with methylene chloride. After solvent exchange to hexane, the extracts are analyzed by gas chromatography using nitrogen-phosphorous detection. Recoveries average higher than 90% with a detection limit of 1 ppb for carbaryl, iprodione, and triadimefon, and 0.1 ppb for chlorpyrifos and isofenphos. (Author's abstract)  
W91-01917

#### REVERSED-PHASE LIQUID CHROMATOGRAPHIC COLUMN SWITCHING FOR THE

#### TRACE-LEVEL DETERMINATION OF POLAR COMPOUNDS. APPLICATION TO CHLOROALLYL ALCOHOL IN GROUND WATER.

Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Organic-Analytical Chemistry.  
E. A. Hogendoorn, A. P. J. M. De Jong, P. Van Zoonen, and U. A. T. Brinkman.  
Journal of Chromatography JOCRAM, Vol. 511, p 243-256, July 1990. 6 fig, 3 tab, 24 ref.

Descriptors: \*Chemical analysis, \*Chromatography, \*Groundwater pollution, \*Laboratory methods, \*Liquid chromatography, \*Pollutant identification, \*Water analysis, Chloroacrylic acid, Dichloropropene, Mass spectrometry, Trace levels, Ultraviolet radiation.

Reversed-phase liquid chromatographic (LC) column switching employing two 18C columns was used for the trace level determination of the polar compound chloroallyl (CAAL), a key metabolite of the soil sterilant dichloropropene, in groundwater. The selectivity of the LC procedure is crucial as CAAL does not possess a chromophoric group and must be detected by UV absorbance at 205 nm. It was shown that the selectivity can be enhanced considerably by the use of a column-switching technique. A completely automated procedure was developed for the determination of CAAL with a limit of detection (LOD) of 1 ppb (signal to noise ratio = 3). Recoveries at the 20 ppb level were 103% for cis-CAAL (relative standard deviation (R.S.D.) = 3.4%) and 102% for trans-CAAL (R.S.D. = 2.5%). Response was linear over more than two decades. The sample throughput is high, as the total time required for the analysis is less than 10 min. If necessary, LODs can be lowered to 0.1 ppb by means of a liquid/liquid extraction combined with a concentration step, resulting in recoveries of 88% (R.S.D. = 4.1%) at a level of 2 ppb. Confirmation of CAAL and a second metabolite of dichloropropene, chloroacrylic acid (CAAC), was performed by gas chromatography-negative ionization chemical mass spectrometry (GC-NCI-MS), using derivatization procedures to convert CAAL and CAAC into their pentafluorobenzoyl derivatives, respectively. (Author's abstract)  
W91-01918

#### TRACE DETERMINATION OF LOWER VOLATILE FATTY ACIDS IN SEDIMENTS BY GAS CHROMATOGRAPHY WITH CHEMICALLY BONDED FFAP COLUMNS.

Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.  
C. A. Hordijk, I. Burgers, G. J. M. Philipsen, and T. E. Cappenberg.  
Journal of Chromatography JOCRAM, Vol. 511, p 317-323, July 1990. 3 fig, 3 tab, 18 ref.

Descriptors: \*Chemical analysis, \*Chromatography, \*Fatty acids, \*Gas chromatography, \*Laboratory methods, \*Pollutant identification, \*Sediment analysis, \*Volatile acids, Formic acid, Freshwater, Trace levels.

A capillary gas-liquid chromatography method was developed for the quantification of free lower volatile fatty acids (LVFA) in freshwater sediments. The method is based on the application of water-resistant FFAP (free fatty acid phase) columns and splitless injection. An important feature is the ability to determine LVFA directly at picomole levels in 1-3 µL of water without sample extraction, clean-up or derivatization. Continuous saturation of the carrier gas with formic acid in superfluus, making this method compatible with mass selective detection. The ability to study LVFA metabolism using stable isotope tracers is presented. The method allows for the measurement of well defined concentration profiles (4-70 µM) in sediment pore waters and is a good alternative to existing techniques for determining trace amounts of LVFA in very small volumes of organic-rich matrices. (Author's abstract)  
W91-01919

#### NOAA'S STATUS AND TRENDS MUSSEL WATCH PROGRAM: CHLORINATED PESTI-

#### CIDES AND PCBs IN OYSTERS (CRASSOSTREA VIRGINICA) AND SEDIMENTS FROM THE GULF OF MEXICO.

Texas A. and M Univ., College Station. Dept. of Oceanography.  
J. L. Sericano, E. L. Atlas, T. L. Wade, and J. M. Brooks.  
Marine Environmental Research MERSDW, Vol. 29, No. 3, p 161-203, 1990. 14 fig, 6 tab, 52 ref.  
National Oceanic and Atmospheric Administration contract 50-DGNC-5-00262.

Descriptors: \*Bioindicators, \*Chlorinated hydrocarbons, \*Gulf of Mexico, \*Mollusks, \*Mussels, \*Oysters, \*Pesticides, \*Sediment contamination, Bioaccumulation, DDD, DDT, Distribution patterns, PCB, Polychlorinated biphenyls.

Chlorinated pesticides and PCB's were analyzed in more than 590 oyster and sediment samples collected during 1986 and 1987, the first 2 years of the NOAA's Status and Trends Mussel Watch Program established to monitor the current status and temporal trends of these contaminants in the Gulf of Mexico. Chlorinated hydrocarbons in oysters and sediments presented similar distribution patterns; however, their concentrations in oysters were several times higher than the concentration detected in the surrounding sediments. Alpha-chlordane, trans-nonachlor and dieldrin were the most abundant non-DDT pesticides in both types of sample. The major fraction of DDT related compounds measured in oysters and sediment was DDD. Based on average PCB concentrations, penta-, hexa-, and tetrachlorobiphenyls were preferentially accumulated by oysters as compared to the average sediment composition. Although this study was designed to avoid known point-sources of contaminant inputs, the measured concentrations were, in general, within the range of concentrations previously reported for the Gulf of Mexico. After the first 2 years of this program, the geographical distribution of chlorinated hydrocarbons in oysters and sediments is well defined. In contrast, the temporal trends at the different sites are not clear. Continued sampling will allow the identification of long-term trends in concentrations of chlorinated hydrocarbons in the Gulf of Mexico. (Author's abstract)  
W91-01933

#### GAS CHROMATOGRAPHY IN ENVIRONMENTAL ANALYSIS: AIMS AND CHALLENGES.

BASF A.G., Ludwigshafen am Rhein (Germany, F.R.). Aktiengesellschaft labor fuer Umweltanalytik und Ökologie.  
H. J. Neu.  
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 337, No. 6, p 583-588, July 1990. 9 ref.

Descriptors: \*Chromatography, \*Gas chromatography, \*Pollutant identification, \*Sensitivity analysis, \*Water analysis, Automation, Mass spectrometry, Organic compounds, Phenols, Qualitative analysis, Quantitative analysis, Trace levels, Wastewater analysis.

Gas chromatography (GC) is currently still the most frequently used technique for determining trace organic compounds in environmental samples. Though GC is already a very highly developed technique, there is still a need for further improvements with respect to the reliability of qualitative and quantitative data and to the overall efficiency of the analysis procedure. Future development should concentrate on all aspects of automation in order to reduce manual work. This refers to automation of pre-chromatographic sample treatment steps such as enrichment, clean-up and derivatization procedures. The derivatization of phenols in water can be considerably simplified by using the reaction of many phenols with pentafluorobenzoylchloride that can be performed directly in alkaline aqueous solution. Using the reagent in a hexane solution, derivatization and extraction of the derivatives can be performed in a single step procedure. Then the organic phase is separated, the excess reagent is destroyed, the extract is dried and subjected to GC-analysis. The

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detection of phenols in wastewater at the picogram level can be performed by a simplification of the above procedure. Derivatization procedures for the determination of hydrophilic compounds in water can also simplify GC analysis. In addition, the sensitivity of GC analysis can be improved by refinements in mass spectrophotometric detector sensitivity. (Geiger-PTT)  
W91-01954

#### TRACE GAS ANALYSIS USING THERMOANALYTICAL METHODS.

Gesamthochschule Wuppertal (Germany, F.R.). Fachbereich 9 - Analytische Chemie. H. Hartkamp, J. Rottmann, and M. Schmitz. *Fresenius Zeitschrift fuer Analytische Chemie ZACFAU*, Vol. 337, No. 7, p 729-736, August 1990. 7 fig, 23 tab, 13 ref.

Descriptors: \*Analytical methods, \*Calorimetry, \*Pollutant identification, \*Trace levels, Chemical reactions, Chlorinated hydrocarbons, Metal complexes, Qualitative analysis, Quantitative analysis, Sampling, Soil gases, Thermal properties, Water pollution.

There is an increasing demand for trace gas analytical information, especially in the fields of environmental protection, due to emissions from soil and water pollution. Most trace analytical procedures are costly, time-consuming and require highly qualified personnel to perform them. This difficulty can be overcome by the development of simple one-step procedures based on low price ready-for-use sampling units which can be processed with a minimum of manpower input while providing information of the required reliability. The measurement of calorific effects associated with the decomposition of the products resulting during the sampling step from a gas-solid reaction between the traces to be analyzed and suitable solid state reagents may provide such needed technology to overcome previous difficulties in trace analysis. Starting from properly prepared test gas mixtures, the gas-solid reactions of numerous amines, alcohols, aldehydes, ketones, hydrocarbons, and halogenated hydrocarbons with several metal complexes and with reagents capable of forming clathrates have been investigated by means of thermogravimetric methods, mainly by means of differential scanning calorimetry. Results show that in many cases the very simple thermoanalytical evaluation enables both qualitative identification and quantification of the gas traces under concern with satisfying selectivity. These reactions may serve as a promising basis for further development of fast, simple and reliable trace gas analyses using thermoanalytical methods. (Author's abstract)  
W91-01955

#### GC-FTIRS: APPLICATIONS IN ORGANIC TRACE ANALYSIS.

Johannes Kepler Univ., Linz (Austria). Dept. of Analytical Chemistry. H. Malissa, T. Kreindl, and K. Winsauer. *Fresenius Zeitschrift fuer Analytische Chemie ZACFAU*, Vol. 337, No. 7, p 843-847, August 1990. 1 fig, 36 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Chromatography, \*Gas chromatography, \*Organic pollutants, \*Pollutant identification, \*Trace levels, \*Water analysis, Atrazine, Herbicides, Spectrophotometry.

The gas chromatography-infrared spectrophotometry (GC-FTIRS) coupling used as a measuring instrument in trace analytical procedures can be fully effective only if the maximum possible sensitivity is provided simultaneously with undistorted chromatographic and spectrometric representation of the eluted compounds. Great efforts have been made in recent years to design improved interfacing and measurement principles. GC capillary separation with flow-through gas cells (light-pipes), matrix isolation and cryodeposition techniques are discussed and compared in terms of sensitivity. The lightpipes achieve a sensitivity of between 1 and 10 nanograms for strong IR-absorbers, although 400 picograms have been attained in a precisely balanced system. For weak IR-absorbers,

the quantity required may raise up to 100 nanograms. In the eluate trapping techniques, identifiable spectrum from 25 picograms has been obtained with the matrix isolation system for the model substance isobutyl methacrylate. The minimum identification concentration of a herbicide in groundwater and drinking water is approximately 1 ppb using an analytical procedure with solid state enrichment, large sample injection and GC-FTIRS with the light-pipe technique. (Geiger-PTT)  
W91-01956

#### DETERMINATION OF ORTHO-AND PYROPHOSPHATES IN WATERS BY EXTRACTION CHROMATOGRAPHY AND FLOW-INJECTION ANALYSIS.

Akademiya Nauk SSSR, Moscow. Inst. Geokhimi i Analiticheskoi Khimii. B. Y. Spivakov, T. A. Maryutina, L. K. Shpigun, V. M. Shkinev, and Y. A. Zolotov. *Talanta TLNTA2*, Vol. 37, No. 9, p 889-894, September 1990. 7 fig, 3 tab, 13 ref.

Descriptors: \*Chromatography, \*Orthophosphates, \*Phosphates, \*Pollutant identification, \*Water analysis, Anions, Cations, Chemical analysis, Separation techniques, Spectrophotometry, Wastewater analysis.

Extraction-chromatographic separation of ortho- and pyrophosphate anions on an inert support modified with an organotin extractant was studied and used for their subsequent determination in a flow-injection analysis (FIA) system. The proposed FIA manifold included an extraction-chromatographic mini-column, on which the phosphate anions were separated and preconcentrated, and a post-column spectrophotometric detector. For the determination of orthophosphate, the absorbance of the reduced 12-molybdophosphoric acid was monitored at 660 nanometers. The sum of ortho- and pyrophosphate was determined after preliminary hydrolysis of pyrophosphate to orthophosphate in neutral solution at 50°C by use of inorganic pyrophosphatase. For a sample volume of 6 ml, the calibration graph was linear within a range of 5.0-100.0 nanograms/ml P. The limit of detection was 0.3 nanograms/ml P. The recovery of the ions to be determined was not less than 96%, the relative error was not worse than 4%. When the proposed method was used for the analysis of river water samples, the deviations between the amounts of phosphate ions found and added were within experimental error. Close agreement was also noted for results achieved with the present method and those obtained by the solvent extraction-spectrophotometric method. The FIA procedure developed can also be applied to the analysis of anions and cations in wastewaters. (Geiger-PTT)  
W91-01962

#### EFFECTS OF SAMPLE PREPARATION ON MEASURED CONCENTRATIONS OF EIGHT ELEMENTS IN EDIBLE TISSUES OF FISH FROM STREAMS CONTAMINATED BY LEAD MINING.

National Fisheries Contaminant Research Center, Columbus, OH. Field Research Station. C. J. Schmitt, and S. E. Finger. *Archives of Environmental Contamination and Toxicology AECTCV*, Vol. 16, No. 2, p 185-207, March 1987. 6 fig, 7 tab, 65 ref. Fish and Wildlife Service and Army Corps of Engineers Interagency Agreement DACW 43-80-A-0109.

Descriptors: \*Analytical techniques, \*Bioaccumulation, \*Biological samples, \*Fish, \*Heavy metals, \*Lead, \*Pollutant identification, \*Sample preparation, \*Tissue analysis, \*Water pollution effects, Animal tissues, Bass, Catfish, Correlation analysis, Mine wastes, Missouri, Path of pollutants, Stream pollution.

The influence of sample preparation on measured concentrations of eight elements in the edible tissues of fish from two rivers in southeastern Missouri contaminated by mining and related activities was investigated. Concentrations of lead (Pb), cadmium (Cd), copper (Cu), zinc (Zn), iron (Fe), manganese (Mn), barium (Ba), and calcium (Ca) were measured in two skinless, boneless samples of

axial muscle from individual fish prepared in a clean room. One sample (normally processed) was removed from each fish with a knife in a manner typically used by investigators to process fish for elemental analysis and presumably representative of methods employed by anglers when preparing fish for home consumption. A second sample (clean-processed) was then prepared from each normally-processed sample by cutting away all surface material with acid-cleaned instruments under ultraclean conditions. The samples were analyzed by atomic absorption spectrophotometry. Only Pb regularly exceeded current guidelines for elemental contaminants in food. Concentrations were high in black redhorse from contaminated sites, regardless of preparation method; for the other fishes, Pb levels depended upon preparation technique. Except for Mn and Ca, concentrations of all elements measured were significantly lower in clean than in normally processed tissue samples. Concentrations of Pb, Ca, Mn and Ba in individual fish were closely correlated regardless of sample size, while correlations between Zn, Fe, and Cd occurred only in normally-processed samples (suggesting that these correlations resulted from high concentrations on the surfaces of some samples). Reported concentrations of certain elements should be regarded only as estimates and regardless of the care exercised during the collection, preparation, and analysis of samples, results should be interpreted with the awareness that contamination from external sources may have occurred. (Author's abstract)  
W91-01968

#### MUTAGENS, TOXICANTS, AND OTHER CONSTITUENTS IN SMALL CITY SLUDGES IN NEW YORK STATE.

Pennsylvania State Univ., University Park. Pesticide Research Lab. R. O. Mumma, K. A. Rashid, D. C. Raupach, B. S. Shane, and J. M. Scarlet-Kranz. *Archives of Environmental Contamination and Toxicology AECTCV*, Vol. 17, No. 5, p 657-663, September 1988. 1 fig, 3 tab, 18 ref.

Descriptors: \*Chemical analysis, \*Hazardous materials, \*Municipal wastes, \*Mutagens, \*New York, \*Pollutant identification, \*Sludge analysis, \*Toxicology, Land disposal, Polychlorinated biphenyls, Radiochemical analysis, Sampling, Surveys.

An analytical survey was conducted of sewage sludges from 15 small cities in New York State for mutagens, 44 elements, polychlorinated biphenyls (PCBs) and radioactivity. Using the Ames salmonella assay, low levels of mutagenicity were detected in several of the samples. PCBs were very high in only one sample, from the Elmira sewage plant (48.4 ppm). A number of toxic elements (i.e., arsenic, boron, barium, cadmium, chromium, copper, mercury, nickel, lead, antimony, and zinc) were found at elevated concentrations in specific sludges, but it is not possible to relate these to specific industrial sources with certainty. The concentrations of specific toxicants in five city sludges were above presently suggested federal guidelines for their suitability for land application. Gamma emission was comparatively low in all samples at 1.6 to 326 cpm per gram above background. Possible sources of specific constituents in sludge are discussed. The concentrations of various constituents in sludges may vary greatly, up or down, with time of sampling, therefore, continuous analytical monitoring for toxicants in sludges is necessary to calculate an average composition for a given period of time if federal guidelines are to be effectively followed. (Author's abstract)  
W91-01974

#### RISK ASSESSMENT OF DRINKING WATER IN A RESERVOIR CONTAMINATED BY PAHS ORIGINATED FROM ROAD TRAFFIC.

Ehime Prefecture Inst. of Public Health, Matsuyama (Japan). For primary bibliographic entry see Field 5C.  
W91-01991

## Identification Of Pollutants—Group 5A

**SUBSTANCE LOAD IN RAINWATER RUNOFF FROM DIFFERENT STREETS IN HAMBURG.** Hamburg Univ. (Germany, F.R.). Inst. fuer Anorganische und Angewandte Chemie. For primary bibliographic entry see Field 5B. W91-01993

**POLLUTION OF STREET RUN-OFF BY TRAFFIC AND LOCAL CONDITIONS.** Umweltbundesamt, Berlin (Germany, F.R.). For primary bibliographic entry see Field 5B. W91-01994

**APPLICATIONS OF MAGNETIC MEASUREMENTS TO SEDIMENT TRACING IN URBAN HIGHWAY ENVIRONMENTS.** Middlesex Polytechnic, Enfield (England). Urban Pollution Research Center. P. R. Beckwith, J. B. Ellis, and D. M. Revitt. The Science of the Total Environment STENDL, Vol. 93, p 449-463, April 1990. 3 fig, 4 tab, 29 ref.

Descriptors: \*Highway effects, \*Magnetic studies, \*Particulate matter, \*Sediment transport, \*Storm runoff, \*Urban areas, \*Urban runoff, Catchment basins, Data acquisition, Hydrology, Sediments.

Mineral magnetic techniques are used to follow the transport and sequencing of surface sediments through a separate stormwater system within a small, well-defined urban catchment. The contributions of these sediments to subsurface deposits and stormwater particulates have been assessed by consideration of magnetic parameter values, by comparison of graphical representations and by derivation of discriminatory equations. A realistic balance is achieved by consideration of each of these. For example, the discrimination procedure predicts that in-pipe deposits collected from below the confluence of the road and roof drainage systems are predominantly categorized as highway associated sediments whereas direct comparison of the appropriate magnetic parameters suggests contributions from both highways and roof areas depending on specific flow characteristics and source sediment loadings. Substantial proportions of the total magnetic mineral loading can occur in the initial stages of the storm events, with as much as 80% of the overall IRM sub 300mT (Isothermal Remanent Magnetization induced by generating a uniform field of 300 mT) loading being discharged in the first 20 minutes, and therefore, these early stages can be important in determining the dominant sediment sources for the overall event. Stormwater quality is shown to be strongly influenced by contributions from atmospheric particulates and the scouring of in-pipe deposits with the latter being dependent upon the dominant sources of stormwater sediment at the end of the preceding storm. (Stoehr-PTT) W91-01997

**INFLUENCE OF COMPLEXING AGENTS AND SURFACTANTS ON METAL SPECIATION ANALYSIS IN ROAD RUNOFF.** Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Sanitary Engineering. G. M. P. Morrison, and T. M. Florence. The Science of the Total Environment STENDL, Vol. 93, p 481-488, April 1990. 4 tab, 13 ref.

Descriptors: \*Chemical analysis, \*Heavy metals, \*Highway effects, \*Pollutant identification, \*Sample preservation, \*Sampling, \*Surfactants, \*Urban runoff, \*Voltammetry, \*Water analysis, Acidity, Cadmium, Copper, Ion exchange, Speciation, Zinc.

A combination of medium exchange and sample acidification techniques are used to calculate the individual effects of complexing agents and surfactants on the deposition and stripping steps in anodic stripping voltammetry (ASV) for copper, lead and cadmium from road and urban runoff. A simple acidification procedure is presented for determining the toxic fraction. ASV is used for the determination of copper in the presence of fulvic and humic acids and Triton X-100, for cadmium and lead in the presence of Triton X-100, and for road and urban runoff samples. The major effects

of both complexing agents and Triton X-100 are on the deposition step. In phosphate buffer pH 7.0, lead is deposited as lead (II), but is stripped as lead (IV), giving enhanced stripping peaks at pH 7.0, but not at pH 1.9. Triton X-100 caused a considerable decrease in the deposition of all three metals, and surfactants were the major cause of low differential pulse ASV (DPASV) labilities in the water samples. Despite these large effects on ASV metal speciation, 5 mg/L of Triton X-100 in the presence or absence of copper had no effect on the growth rate of *Chlorella pyrenoidosa* at pH 7.0. This result has important implications for the use of DPASV lability in estimating the 'toxic fraction' of a metal. Since surfactants in road runoff are the dominant factor in the decrease of ASV lability, but do not decrease metal toxicity toward aquatic test organisms, then ASV will seriously underestimate the toxic fraction. This study has demonstrated several potential problems in the application of ASV lability measurements to the estimation of the toxic fraction of a metal in road runoff samples. The use of membrane-coated electrodes or direct current with peak integration, rather than either differential pulse-, or square wave-ASV, will eliminate the effect of the stripping step on ASV lability, but surfactants will still influence deposition. The measurement required for toxicity studies, i.e., the effect of complexing agents on deposition, can be readily obtained by DPASV using two successive ASV-labile determinations in the same sample aliquot with a simple acidification procedure. (Stoehr-PTT) W91-01999

**APPLICATION OF MULTIVARIATE ANALYSIS FOR CHARACTERIZATION OF ORGANIC COMPOUNDS FROM URBAN RUNOFF.** Universidad Politécnica de Madrid (Spain). Escuela Técnica Superior de Ingenieros de Caminos. M. T. Bombal, A. Fernandez, F. Marino, and E. Hontoria. The Science of the Total Environment STENDL, Vol. 93, p 523-536, April 1990. 3 fig, 2 tab, 23 ref.

Descriptors: \*Aliphatic hydrocarbons, \*Fatty acids, \*Hydrocarbons, \*Multivariate analysis, \*Organic compounds, \*Pollutant identification, \*Spain, \*Urban runoff, Madrid, Mathematical analysis, Pollutants.

A one year study for determining the concentrations of aromatic and aliphatic hydrocarbons and fatty acids in urban runoff has been established in Madrid. Seasonal traffic and area variations were studied to calculate enrichment factors after which apportionment techniques were used. Hierarchical cluster analysis was used to identify urban runoff in homogeneous classes. Squared euclidean distance was used as a measure to calculate the similarity between samples and the mean distance was employed as the fusion strategy to obtain the dendrogram. Factor analysis was developed to determine sources of urban runoff pollutants. The Varimax rotation technique was chosen to resolve organic compound origins and obtain their profiles and contributions to the receptor site. The results show that pyrolytic, petrogenic and natural sources are the main components of hydrocarbons and fatty acids in urban runoff. (Author's abstract) W91-02004

**RECENT TAXONOMIC DISCOVERIES CONCERNING THE MUSSEL MYTILUS: IMPLICATIONS FOR BIOMONITORING.** Memorial Univ. of Newfoundland, St. John's. Dept. of Earth Sciences. P. B. Lobel, S. P. Belkhead, S. E. Jackson, and H. P. Longrich. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 508-512, July/August 1990. 3 tab, 14 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Marine pollution, \*Mollusks, \*Mussels, \*Taxonomy, Growth rates, Mass spectrometry, Metabolism, Speciation.

The mussel *Mytilus* has been widely used as a bioindicator of marine pollution. Because of its wide distribution around the world, it has been

possible to establish a global 'mussel watch' to monitor pollutants in the marine environment. Recent taxonomic discoveries based on studies of allozyme variation, however, have shown that *Mytilus edulis* is actually a complex consisting of three separate evolutionary lineages which deserve the ranks of separate species: the Atlantic *Mytilus edulis*, *Mytilus galloprovincialis*, and *Mytilus trossulus*. Many mussels previously classified as *Mytilus edulis* can be reclassified as either *Mytilus galloprovincialis* or *Mytilus trossulus*. In the present study, specimens of *Mytilus edulis* and *Mytilus trossulus* were collected from the same habitat and analyzed for the concentrations of 25 elements by inductively coupled plasma mass spectrometry. *Mytilus trossulus* had higher element concentrations than *Mytilus edulis*. Differences between the element concentrations of the two species were related to differences in growth rather than to any direct differences between the element metabolism of the species. Such differences could be corrected by standardizing the mussels to a fixed width/height ratio. In order to avoid errors in future monitoring programs, taxonomic variables should be considered. (Author's abstract) W91-02030

**EXPRESSION OF RESULTS FROM GROWTH INHIBITION TOXICITY TESTS WITH ALGAE.** Vandkvalitetstestinstutet, Hoersholm (Denmark). For primary bibliographic entry see Field 5C. W91-02031

**MULTIRESIDUE METHOD BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY-BASED FRACTIONATION AND GAS CHROMATOGRAPHIC DETERMINATION OF TRACE LEVELS OF PESTICIDES IN AIR AND WATER.**

California Univ., Davis. Dept. of Environmental Toxicology. J. N. Seiber, D. E. Glofely, A. D. Lucas, M. M. McChesney, and J. C. Sagebiel. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 583-592, July/August 1990. 5 fig, 5 tab, 25 ref. NIEHS Grant No. ES04699.

Descriptors: \*Air pollution, \*Analytical methods, \*Chromatography, \*Gas chromatography, \*High performance liquid chromatography, \*Path of pollutants, \*Pesticides, \*Pollutant identification, \*Water pollution, Carbamate pesticides, Organophosphorus pesticides, Silica gel fractionation, Solutes.

A multiresidue analytical method, accommodating chemicals over a broad range of polarities, is outlined for pesticides, transformation products, and related toxicants based upon high performance liquid chromatographic fractionation of extracted residue on a Partisil silica gel normal phase column followed by selective-detector gas chromatographic determination of components in each fraction. The HPLC mobile phase gradient (hexane to methyl t-butyl ether) gave good chromatographic efficiency, resolution, reproducibility and recovery for 61 test compounds, and allowed for collection in four fractions spanning polarities from low polarity organochlorine compounds (fraction 1) to polar N-methylcarbamates and organophosphorus oxons (fraction 4). The multiresidue method was developed for use with air samples collected on XAD-4 and related trapping agents, and water samples extracted with methylene chloride. Detection limits estimated from spiking experiments were generally 0.3 to 1 ng/c m for high volume air samples, and 0.01 to 0.1 microg/L for one liter water samples. The combination of silica gel HPLC fractionation with element selective GC determination appears to offer several advantages when combined in a multiresidue method. The HPLC fractionation gives clean separation on the basis of solute polarity, and fraction cuts may be tailored to meet the needs of a given analytical problem. This technique can analyze pesticides and related compounds in air and water samples. (Brunone-PTT) W91-02038

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

#### 5B. Sources Of Pollution

##### METAL CONTENT OF FUNGAL SPOROCARPS FROM URBAN, RURAL, AND SLUDGE-TREATED SITES.

Pacific Northwest Forest and Range Experiment Station, Wenatchee, WA. Forestry Sciences Lab. D. Zabowski, R. J. Zasoski, W. Little, and J. Ammirati.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 372-377, July/September 1990. 1 fig, 4 tab, 24 ref.

Descriptors: \*Fungi, \*Path of pollutants, \*Sludge, \*Soil contamination, \*Trace metals, \*Washington, Cadmium, Copper, Food chains, Forests, Iron, Manganese, Nickel, Rural areas, Urban areas, Zinc.

Fungal sporocarps can influence metal cycling by the uptake of trace metals, which are then readily available for consumption and incorporation into higher food chain levels. This study was conducted to determine if increased sporocarp metal (Cd, Cu, Fe, Mn, Ni, Zn) concentrations occurred relative to substrate metal availability in rural, urban, and sludge-treated sites in western Washington state. Fungal fruiting bodies were collected from rural forests, from urban forests receiving point-source metal pollution and from forests that had been treated with municipal sewage sludge. Metal concentrations in fungal sporocarps were found to be significantly higher on sewage sludge-treated sites when all species were considered. Smelter pollution and serpentine soil, however, were also found to elevate some metals to levels similar to those found at sludge-amended areas. Overall, individual species appear to be the most important factor for predicting metal uptake from impacted soils and possible inclusion into food chains. (Author's abstract)  
W91-01005

##### AQUEOUS BEHAVIOR OF CHROMIUM IN COAL FLY ASH.

Battelle Pacific Northwest Labs., Richland, WA. Environmental Sciences Dept. D. Rai, and R. W. Szelmecka.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 378-382, July/September 1990. 5 fig, 3 tab, 14 ref. Electric Power Research Institute, Inc. Contract RP2485-08.

Descriptors: \*Chromium, \*Coal wastes, \*Path of pollutants, Chemical analysis, Chemical reactions, Chromium compounds, Coal fly ash, Hydrogen ion concentration, Interstitial water.

Although the average Cr content in coal fly ash is fairly small, a total of approximately 17,000 mg of Cr contained in fly ash is disposed of on the land surface in the U.S. annually. Because Cr, especially Cr(VI), is hazardous even in small quantities, it is important to determine or predict pore-water Cr concentrations. Studies were conducted to determine the dominant reactions controlling aqueous Cr concentrations in four coal fly ashes. The fly ashes were adjusted to a range of pH values between 2 and 10. Cr was found to be present in these aqueous and solid phases as Cr(III). Because of the amorphous character of the important Cr(III) compounds ((Fe,Cr)(OH)<sub>3</sub> and Cr(OH)<sub>3</sub>) and because of the very low total Cr content of the fly ashes (<0.025%), it was not possible to identify directly the Cr-containing compounds. However, an indirect technique for identifying Cr compounds, comparison of observed activities with those in equilibrium with known solid phases, and with those obtained after spiking the coal ash suspensions with Cr(III), suggested that Cr concentrations are controlled by (Fe,Cr)(OH)<sub>3</sub>(am) at low pH and by (Fe,Cr)(OH)<sub>3</sub>(am) and/or Cr(OH)<sub>3</sub>(am) at pH values greater than about 5. (Author's abstract)  
W91-01006

TEMPORAL SOLUBILITY TRENDS OF ALUMINUM AND IRON LEACHED FROM COAL SPOILS AND CONTAMINATED SOIL MATERIALS.  
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.

A. D. Karathanasis, Y. L. Thompson, and V. P. Evangelou.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 389-395, July/September 1990. 10 fig, 1 tab, 25 ref.

Descriptors: \*Acid mine drainage, \*Aluminum, \*Coal spoil, \*Iron, \*Path of pollutants, Kentucky, Leaching, Sediment contamination, Soil columns, Soil contamination, Solubility, Watersheds.

Column leaching experiments were conducted over a period of 5 months on selected spoil, soil, and sediment samples collected from acid mine watersheds with low buffering capacity in Kentucky. Evaluation of effluent compositions over time suggested that at different stages of leaching these samples may release different levels of Al and Fe. These levels appeared to be controlled by the solubility of characteristic sequences of basic Al-sulfate, Al-hydroxide, and aluminosilicate minerals, or Fe-sulfate and Fe-hydroxide minerals, which are sample specific. Jarbanite-jarbanite, jarbanite-alunite, and jarbanite-alunite-microcrystalline gibbsite appeared to be the dominant mineral species controlling the solubility of Al. Similarly, the jarosite-amorphous Fe(OH)<sub>3</sub> and amorphous Fe(OH)<sub>3</sub>-geothite sequences appeared to control the solubility of Fe. Alternating water saturation and desaturation cycles appeared to cause more drastic changes in the above relationships than different flow rates simulating rain events of different intensity. The findings suggest that understanding temporal relationships among the sequence of mineral phases controlling Al and Fe solubility is essential for realistic modeling of Al and Fe release into aquifers. (Author's abstract)  
W91-01007

##### VIRUS TRANSPORT AND SURVIVAL IN SATURATED AND UNSATURATED FLOW THROUGH SOIL COLUMNS.

Arizona Univ., Tucson. Dept. of Soil and Water Science. D. K. Powelson, J. R. Simpson, and C. P. Gerba.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 396-401, July/September 1990. 4 fig, 4 tab, 36 ref. USEPA CR-81147.

Descriptors: \*Groundwater pollution, \*Path of pollutants, \*Viruses, \*Water pollution, Saturated flow, Soil adsorption, Soil columns, Survival, Unsaturated flow.

Water with entrained disease-causing virus entering soil normally passes through water saturated and unsaturated regions before reaching the groundwater. The effects of saturated and unsaturated flow on the survival and transport of a virus, MS-2 bacteriophage, were compared. The viruses were added to well water and applied to soil columns 0.052 m in diameter and 1.05 m long. The soil material was Vint loamy fine sand (a sandy, mixed, hyperthermic Typic Torrifluvent) mixed with recent alluvium. Samples of the soil water were taken daily at 0.20, 0.40, and 0.80 m depths through stainless steel samplers and at 1.05 m from the percolate leaving the column. For saturated flow the virus concentrations reached the influent concentration in less than two pore volumes (PV). For unsaturated flow the concentrations remained at levels much lower than the influent, ranging from 27% of inflow at 0.20 m (18 PV) to 5% at 1.05 m (3.3 PV). At the end of the experiments soil samples from each depth were assayed to determine virus adsorption to the soil. The average distribution coefficient of the unsaturated columns, 0.27, indicates very little adsorption. The number balance showed that only 39% of the unsaturated flow virus were accounted for. It appears that under unsaturated flow conditions enhanced inactivation of this virus occurs. (Author's abstract)  
W91-01008

NUTRIENT EXPORT IN STORMFLOW FOLLOWING FOREST HARVESTING AND SITE-REPREPARATION IN EAST TEXAS.  
Agricultural Research Service, Boise, ID. Northwest Watershed Research Center. W. H. Blackburn, and J. C. Wood.

Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 402-408, July/September 1990. 4 fig, 4 tab, 31 ref.

Descriptors: \*Clear-cutting, \*Forest management, \*Nutrient transport, \*Water pollution sources, Agricultural practices, Field tests, Small watersheds, Storm runoff, Texas, Water quality, Water quality monitoring.

In December 1979 nine small (2.57 to 2.79 ha) watersheds in East Texas were instrumented to determine the effects on stormflow water quality of: (1) clearcutting, shearing, windrowing, and burning; (2) clearcutting, roller chopping, and burning; and (3) undisturbed control. Nutrient losses and concentrations, pH, electrical conductivity, and turbidity were not significantly different for all pre-treated watersheds. The first year following harvesting and site preparation, most nutrient losses and concentrations were greater from the sheared and cropped watersheds than from the undisturbed watersheds. Most nutrient losses and concentrations during the second and third post-treatment years were not significantly different from the chopped and undisturbed watersheds, but continued to be significantly greater from the sheared watersheds than from chopped or undisturbed watersheds. During the fifth post-treatment year all nutrient levels except for K(+) losses were not significantly different for all treatments. Although nutrient losses from all treatments were small, shearing and windrowing had the greatest impact on nutrient export. Roller chopping as applied in this study had a minimal impact on stormflow nutrient losses and should not degrade water quality. (Author's abstract)  
W91-01009

##### BATCH LEACHING STUDIES OF RUNDLE OIL SHALE.

Commonwealth Scientific and Industrial Research Organization, North Ryde (Australia). Div. of Coal Technology. D. R. Jones.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 408-413, July/September 1990. 3 fig, 4 tab, 16 ref.

Descriptors: \*Arsenic, \*Australia, \*Oil shale, \*Oil wastes, \*Path of pollutants, \*Trace metals, Batch tests, Hydrogen ion concentration, Kerosene Creek, Leachates, Rundle prospect, Solid wastes, Telegraph Creek.

Disposal of overburden, waste shale, and retorted shale may pose a significant environmental problem in the commercial exploitation of the oil shale in the Rundle prospect near Gladstone, Australia. The leaching of Fe, Mn, Al, Zn, Cd, Pb, Ni, Cu, As, and Se from samples of raw and retorted Kerosene Creek seam oil shale and Telegraph Creek seam claystone from the Rundle oil shale deposit was studied over the pH range 2 to 9.5. Low pH values were used to simulate the effects of possible acidification that might occur by oxidation of pyrite contained in the solids. The variation in leachate composition with pH highlighted the shortcomings of any batch test that seeks to categorize the behavior of a waste material solely on the basis of extraction at a single pH value. In this context, the results provided by the Resource Conservation and Recovery Act (RCRA) toxicity and American Society for Testing and Materials (ASTM) leach tests were compared. The RCRA test would not have identified As as being a potential problem in leachate from the retorted shale, because, at pH 5, this element (in the form of arsenate) is strongly absorbed by the shale matrix. The natural pH of a slurry of this waste is, however, greater than 9. Under these conditions, As is the trace element present in the highest concentrations in the leachate. (Author's abstract)  
W91-01010

##### DISSOLVED AND SUSPENDED SOLIDS TRANSPORT FROM COASTAL PLAIN WATERSHEDS.

Agricultural Research Service, Tifton, GA. Southeast Watershed Research Lab.

## Sources Of Pollution—Group 5B

R. K. Hubbard, J. M. Sheridan, and L. R. Marti.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 413-420, July/September 1990. 5 fig, 1 tab, 30 ref.

Descriptors: \*Dissolved solids, \*Georgia, \*Path of pollutants, \*Sediment transport, \*Suspended solids, \*Water pollution sources, \*Water quality, Base flow, Coastal plains, Sediment concentration, Sediment load, Small watersheds, Surface runoff.

Excessive amounts of dissolved or suspended solids in surface runoff or base flow may degrade the quality of streams, lakes, or other water bodies. Loads of dissolved or suspended solids in streamflow reflect the quality of water entering via surface runoff or base flow. This study was conducted to determine the concentrations and loads of dissolved and suspended solids in Coastal Plain streamflow; to examine relationships between concentrations, loads, and flow rate; and to determine overall streamflow water quality for these parameters. Dissolved solids and suspended sediment concentrations were determined on weekly or high flow storm event streamflow samples collected at gaging stations on three subwatersheds (B, 334.3 sq km; F, 114.9 sq km; and K, 16.7 sq km) of the Little River Watersheds located near Tifton, Georgia. Dissolved solids concentrations ranged from 19 to 159 mg/L, and generally decreased as per unit area instantaneous discharge rate increased. Suspended sediment concentrations ranged from 1 to 137 mg/L, and generally increased as per unit area discharge rate increased. Regression analyses showed strong correlation between log transforms of both dissolved solids load and suspended sediment load versus total monthly runoff (correlation coefficients of 0.97 and 0.79, respectively). Mean suspended sediment concentrations during high flow events were greater than means from the overall data set, while mean concentrations of dissolved solids were reduced relative to the overall data set. The results showed that dissolved solids are the major component of total solids in Coastal Plain streamflow. The mean dissolved and suspended sediment concentrations during the study were 67, 60, and 51 mg/L; and 14, 17, and 14 mg/L for Watersheds B, F, and K, respectively. Overall, it was demonstrated that, as measured on these watersheds, Coastal Plain streamflow is of good quality in terms of both dissolved and suspended solids. This good quality may reflect land use practices designed to prevent soil erosion, but primarily reflects the Coastal Plain landform shape, which causes sediments eroded from the uplands to be deposited in the riparian zone before they can enter the streamflow. (Author's abstract) W91-01011

**INFLUENCE OF WATER CHEMISTRY ON SUSPENDED SOLIDS IN COAL MINE SEDIMENTATION PONDS.**  
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.  
For primary bibliographic entry see Field 5D. W91-01013

**EFFECT OF CONVENTIONAL VS. NO-TILLAGE ON PESTICIDE LEACHING TO SHALLOW GROUNDWATER.**  
Agricultural Research Service, Beltsville, MD.  
A. R. Isensee, R. G. Nash, and C. S. Helling.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 434-440, July/September 1990. 6 fig, 1 tab, 23 ref.

Descriptors: \*Agricultural practices, \*Groundwater pollution, \*Maryland, \*No-till cultivation, \*Path of pollutants, \*Pesticides, Beltsville, Confined groundwater, Leaching, Monitoring wells, Rainfall impact, Tillage, Unconfined groundwater.

A field site was established at Beltsville, Maryland, in 1986 to assess the effect of conventional and no-till cultural practices on the movement of pesticides into shallow groundwater. Groundwater samples taken from unconfined (<1.5 m deep) and confined (>3 m deep) monitoring wells in 1986-1988 were analyzed for atrazine, deethylatrazine, alachlor, cyanazine, and carbofuran. Atrazine was found in groundwater all year, while cyanazine,

alachlor, and carbofuran were present only for a short period (<3 mo) after pesticide application. Fairly constant background levels of <0.5 microg/L atrazine were found under fields treated before 1986, while levels under continuously treated fields were <2.0 microg/L for 22 of 25 samplings. Pesticide residues in unconfined groundwater were usually higher (ca. 2 to 4 fold) than in confined groundwater. Rainfall timing relative to pesticide application was critically important to pesticide leaching. A prolonged rain immediately after the 1988 application resulted in peak atrazine and cyanazine levels ca. 200 microg/L in unconfined and 30 to 40 microg/L in confined groundwater, which resulted in short term levels 2 to 50 fold greater under no-till than conventional till plots. The results suggest that preferential transport occurred. (Author's abstract) W91-01014

**NITRATE CONTAMINATION OF GROUNDWATER UNDER IRRIGATED COASTAL PLAIN SOILS.**  
Maryland Univ., College Park. Dept. of Agronomy.  
R. R. Weil, R. A. Weismiller, and R. S. Turner.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 441-448, July/September 1990. 3 fig, 7 tab, 12 ref.

Descriptors: \*Groundwater pollution, \*Nitrates, \*Nonpoint pollution sources, \*Path of pollutants, \*Water pollution sources, Agricultural runoff, Coastal plains, Denitrification, Fertilizers, Forests, Irrigation effects, Leaching, Manure, Maryland, Monitoring wells, Seasonal variation.

To develop best management practices (BMP) for agricultural land to protect groundwater, data is needed on the leaching of N from irrigated coastal plain soils treated with poultry manure. This study was conducted to determine the vertical and seasonal patterns of nitrate leaching under such soils. Four commercially farmed corn (Zea mays L.) fields were studied, two receiving only fertilizer N (240-360 kg N/ha over a two year period) and two with a continuing history of poultry manure applications (25-29 Mg/ha over 2 yr). In each field, a transect of four monitoring wells was installed 4 to 8 m deep (1 m below the seasonally low water table). Three additional wells were installed in forestland adjacent to three of the fields. Groundwater and soils (to 1.5 m depth) were periodically sampled for analysis of nitrate N. Under the unmanured field, groundwater nitrate N concentrations averaged 15.1 mg/L during August through November 1986, while the corresponding figure for the manured fields was not significantly different at 18.3 mg/L. Two months after spreading manure in November and December, as much as 104 mg/L nitrate N was measured in the groundwater under the manured fields. From December 1986 through September 1987 the groundwater under the manured fields had significantly higher nitrate N concentrations than did that under the unmanured fields (43.7 vs. 18.1 mg/L, respectively). Only for one well site with a buried A horizon did high Cl to nitrate N ratios and low nitrate N concentrations indicate rapid denitrification. The forestland groundwater always contained <1 mg/L nitrate N, and high Cl to nitrate N ratios, suggesting that nitrate in the cropland groundwater was lost after entering the forested areas, and that forests may therefore protect waterways from subsurface N contamination. (Author's abstract) W91-01015

**NITRATE LEACHING FROM SYSTEMATICALLY TILED POTATO FIELDS IN NEW BRUNSWICK, CANADA.**  
Agriculture Canada, Fredericton (New Brunswick). Research Station.  
P. Milburn, J. E. Richards, C. Gartley, T. Pollock, and H. O'Neill.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 448-454, July/September 1990. 2 fig, 5 tab, 34 ref.

Descriptors: \*Agricultural runoff, \*Crops, \*Drainage, \*Nitrates, \*Nonpoint pollution sources, \*Path of pollutants, \*Water pollution sources, Canada,

Fertilizers, Leaching, Mineralization, New Brunswick, Nitrogen, Potatoes, Seasonal variation, Water quality.

Flow volumes and nitrate N concentrations of drain discharge from five systematically tiled, commercial potato (*Solanum tuberosum* L.) fields were measured from April to December, 1987 and 1988 to assess the potential for nitrate N leaching associated with current production practices. The sites, located in New Brunswick, Canada, ranged from 3 to 10 ha and varied in fertilizer application rate, cropping practices, rainfall, and duration of data collection (the last due to site access difficulties in the spring). Three of the five sites were representative of intense potato rotations, whereas the remaining two were representative of land conversions into potato production from more passive, low input production systems. Ten site-years of data were collected. Drain outflow volumes averaged 75 and 115 mm per unit area in 1987 and 1988, respectively. Considerable drain flow occurred during snowmelt each year before data collection began. Measured nitrate N concentrations ranged from 1 to 65 mg/L and there were substantial variations within flow events. The flow weighted average annual nitrate concentrations of the drainage effluent were greater than or equal to 10 mg/L for potato site-years, regardless of whether the sites were established potato rotation fields or not. The flow weighted nitrate concentrations of the established potato rotation sites also remained >10 mg/L for the first non-potato year following a potato year. The flow weighted nitrate concentration of one potato rotation site was more than double that of the other two sites. Incubation studies showed that the soil at this site had considerably more potential to mineralize N than the other two sites. Total nitrate N leaching for the potato site-years for the measured April to December periods ranged from 5 to 33 kg N/ha. More work, under controlled conditions, is required to determine both dormant and growing season nitrate N leaching associated with various potato production systems. (Author's abstract) W91-01016

**ASSESSMENT OF CUMULATIVE IMPACTS TO WATER QUALITY IN A FORESTED WETLAND LANDSCAPE.**  
Clemson Univ., Georgetown, SC. Belle W. Baruch Forest Science Inst.  
For primary bibliographic entry see Field 4C. W91-01017

**LEACHING OF RADIONUCLIDES FROM DECAYING BLUEBERRY LEAVES: RELATIVE RATE INDEPENDENT OF CONCENTRATION.**  
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.  
S. C. Sheppard, and W. G. Evenden.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 464-469, July/September 1990. 1 fig, 2 tab, 24 ref.

Descriptors: \*Food chains, \*Leaching, \*Path of pollutants, \*Radioisotopes, \*Sediment transport, Cesium radioisotopes, Decomposition, Iodine radioisotopes, Leaves, Mathematical models, Radiochemical analysis, Selenium radioisotopes, Uranium radioisotopes, Vegetation effects.

Leaching of radionuclides from decaying vegetation has not been extensively investigated, especially for radionuclides other than Cs-137. Leaves of blueberry (*Vaccinium angustifolium* x *V. corymbosum*) were obtained that contained over 25-fold ranges in Se, Cs, and I concentrations, as well as a small quantity of leaves containing detectable U. All were contaminated by way of root uptake. Leaching took place for a period of 1 yr in the laboratory using leach water from forest litter. Monthly measurements were made of the radionuclide contents and decaying leaf dry weights. The data conformed to an exponential decay model with two first-order components. In no case did the relative loss rates vary systematically with the initial tissue radionuclide concentrations. Loss rates decreased in the order Cs>I>U>dry wt>Se. Because of the low leaching rate of Se

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

relative to the loss of dry weight, decaying litter may actually accumulate elements such as Se. Accumulation of radionuclides in litter could have important implications for lateral transport, recycling, and direct incorporation into edible mushrooms. (Author's abstract)  
W91-01018

**AEROBIC AND ANAEROBIC DEGRADATION OF ALACHLOR IN SAMPLES FROM A SURFACE-TO-GROUNDWATER PROFILE.**  
Agricultural Research Service, Stoneville, MS. Southern Weed Science Lab.  
J. V. Potthuri, T. B. Moorman, D. C. Obenhuber, and R. D. Wauchop.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 525-530, July/September 1990. 2 fig, 4 tab, 26 ref.

Descriptors: \*Alachlor, \*Biodegradation, \*Fate of pollutants, \*Georgia, \*Herbicides, \*Soil contamination, Aerobic conditions, Anaerobic conditions, Aquifer testing, Microbial degradation, Plains, Vadose zone.

Estimates of pesticide degradation rates in subsoils are needed to improve models predicting pesticide movement to groundwater. Biodegradation rates of the herbicide alachlor (2-chloro-(2,6-diethylphenyl)-N-(methoxymethyl)acetamide) in surface soil, vadose zone, and aquifer samples collected from a single site near Plains, Georgia were determined in the laboratory under aerobic and anaerobic conditions. Degradation was described by first-order kinetics during 126 d of incubation. Under aerobic conditions the half-life of alachlor in the surface soil (23 d) was less than in the vadose zone (73-285 d) and aquifer samples (320-324 d). Alachlor in anaerobic samples degraded less rapidly in the surface (0 to 0.6 m) and the next deepest (0.6 to 2.4 m) subsoil than under aerobic conditions (half-life of 100 and 144 d, respectively). Degradation in anaerobic aquifer samples was very slow (half-life of 337 to 553 d). Addition of organic nutrients enhanced aerobic degradation in subsurface soils and one aquifer sample, indicating that nutrient availability limits biodegradation. Total aerobic microbial populations ranged from  $6.6 \times 10^3$  to  $2.5 \times 10^6$  cells per gram of soil in the subsoils and aquifer samples, but were not correlated with aerobic or anaerobic degradation rates. The lower degradation rates in vadose zone and aquifer materials may be due to less microbial activity or the absence of alachlor degraders. (Author's abstract)  
W91-01019

**METOLACHLOR TRANSPORT IN SURFACE RUNOFF.**  
Trent Univ., Peterborough (Ontario). Dept. of Geography.  
J. M. Buttle.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 531-538, July/September 1990. 7 fig, 5 tab, 23 ref.

Descriptors: \*Agricultural runoff, \*Herbicides, \*Metolachlor, \*Ontario, \*Path of pollutants, \*Water pollution, Adsorption, Agricultural practices, Canada, Sediment contamination, Soil contamination, Surface runoff, Transport.

In 1987 metolachlor (2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide) was applied to a 5.5 ha corn field in southern Ontario, Canada, in two separate areas: as a pre-emergence surface spray with cross-contour plowing and as a pre-plant incorporated treatment with contour plowing. The application rate for both treatments was 2.64 kg a.i./ha. Metolachlor concentrations in soils and in the dissolved and adsorbed phases in runoff from natural rainstorms were monitored throughout the growing season. Persistence in soils decreased exponentially after application although there was evidence of temporary accumulation of metolachlor in footslope areas. Dissolved concentrations in runoff decreased with time while temporal trends in adsorbed concentrations reflected changes in metolachlor persistence in soils. Average ratios of adsorbed to dissolved herbicide concentrations ranged from 7 to 57, and were dependent upon

hydrological and pedologic conditions within the treatments. Sediment carried between 9 to 58% of the total metolachlor yield from runoff plots during individual storms, and 20 to 46% of the total yield over the monitoring period. Herbicide incorporation and contour plowing led to significant reductions in dissolved and adsorbed concentrations, and in total metolachlor loss in runoff, relative to application as a preemergence spray with cross-contour plowing. Incorporation was associated with an increase in the relative importance of sediment in metolachlor transport. Variations in herbicide losses and the relative importance of transport vectors within a given treatment were linked to local hydrological processes. (Author's abstract)  
W91-01020

**ASSESSMENT OF MANAGEMENT PRACTICES FOR REDUCING PESTICIDE RUNOFF FROM SLOPING CROPLAND IN ILLINOIS.**  
Illinois Natural History Survey, Champaign.  
For primary bibliographic entry see Field 5G.  
W91-01021

**ATRAZINE AND BROMIDE MOVEMENT THROUGH A SILT LOAM SOIL.**  
Agricultural Research Service, Beltsville, MD. Environmental Chemistry Lab.  
J. L. Starr, and D. E. Giotfelty.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 552-558, July/September 1990. 7 fig, 2 tab, 16 ref.

Descriptors: \*Agricultural chemicals, \*Agricultural practices, \*Atrazine, \*Bromides, \*Leaching, \*Path of pollutants, \*Pesticides, Cultivation, Groundwater pollution, Soil cores, Soil types, Tillage.

The movement of agrochemicals through soil to groundwater is affected by soil properties, soil management, timing of leaching events, and kinetics of the transformation processes. This study was conducted to determine the pattern(s) of movement of Br and atrazine (2-chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine) through a field soil as affected by plow-till and conservation-till corn (*Zea mays* L.) under severe leaching conditions. The soil surface inside double-ring infiltrometers was sprayed with chemicals. One week later 10 cm of solution was applied under ponded flow conditions, and soil cores removed the next day for chemical analysis. The distribution patterns of Br and atrazine with soil depth were quite similar, with the largest proportion of the chemicals observed in the surface horizon, yet all cores showed some movement of chemicals to the deepest sampling depth (90 cm). However, on average <30% of the applied water, Br, and atrazine could be found. Two quite different processes seem to be involved in the movement of these chemicals through this soil: one-dimensional movement through the soil matrix and rapid downward movement through macropores which bypassed most of the soil matrix. The data suggest that the leaching losses of agrochemicals during the typical leaching season in eastern regions of the U.S. (fall to spring), may not be greatly affected by tillage. (Author's abstract)  
W91-01022

**SORPTION OF NAPROPAMIDE ON CLAY AND SOIL IN THE PRESENCE OF DISSOLVED ORGANIC MATTER.**  
National Taiwan Univ., Taipei. Dept. of Agricultural Chemistry.  
D.-Y. Lee, W. J. Farmer, and Y. Aochi.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 567-573, July/September 1990. 3 fig, 5 tab, 14 ref.

Descriptors: \*Napropamide, \*Organic matter, \*Path of pollutants, \*Pesticides, \*Soil contamination, \*Sorption, Clays, Dissolved solids, Isotherms, Nonionic pesticides, Sediments, Soil types.

Dissolved organic matter (DOM) can affect the distribution of solutes between solution and sorbed phases and the availability and environmental fate

of the solutes. Batch sorption isotherm techniques were used to evaluate solute-solute and solute-sorbent interactions that control the effects of DOM on the sorption of a nonionic, moderately polar organic solute by solid sorbents. The sorption of napropamide (2-(alpha-naphthoxy-N,N-diethyl propionamide) by Na-, Cu-, and Al-montmorillonite decreased when dissolved humic acid derived from peat was present in the slurry. For Na-montmorillonite, the effect of DOM on sorption was reduced when a dialysis membrane prevented the contact between the DOM and the clay. This suggests that competition for sorption sites on the clay between DOM and the pesticide contributed to decreased napropamide sorption. The extent of the DOM effect was also dependent on the concentration and the source of DOM added. In contrast to the montmorillonite system, the effect of DOM on napropamide sorption by soil was observed only when the dialysis membrane was present or when the dissolution of native organic matter from the sorbate surface itself was enhanced by increasing the pH of the slurry system. These results demonstrate that the effect of DOM on the sorption of nonionic pesticides by soils and sediments can be a function of the association of DOM with pesticides in the solution phase, interactive forces of both DOM and the pesticide with the sorbent surface, and the nature of the sorbent surface. (Author's abstract)  
W91-01023

**BEHAVIOR OF TOLUENE ADDED TO SLUDGE-AMENDED SOILS.**  
New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.  
Y. Jin, and G. A. O'Connor.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 573-579, July/September 1990. 5 fig, 3 tab, 22 ref. USEPA Cooperative Agreement CR-812687-02.

Descriptors: \*Fate of pollutants, \*Organic compounds, \*Path of pollutants, \*Sludge utilization, \*Soil contamination, \*Toluene, Adsorption, Organic carbon, Sludge, Sludge-treated soils, Soil types, Volatilization, Waste disposal.

Toluene is a priority pollutant that can be introduced to soils in a variety of wastes, including some municipal sludges. Laboratory experiments were conducted to study the behavior of toluene in two soils in the presence and absence of municipal sludge. Sludge additions increased toluene adsorption in two soils because of increased organic C content. The source of organic C (soil or sludge) and soil clay content also influenced toluene adsorption. Toluene adsorption-desorption was reversible in one soil, but slightly hysteretic in the other soil. An air-flow incubation system was used to evaluate toluene volatilization and degradation. The primary fate of surface-applied toluene in both soils was volatilization. Toluene volatilization rates were independent of sludge treatments. Toluene degradation was negligible in all treatments because of rapid volatilization losses. Despite increased toluene adsorption in the presence of sludge and reduced volatilization in saturated soils, gaseous transfer dominated all soils and treatments so that no toluene remained after 10 d. (Author's abstract)  
W91-01024

**EFFECT OF MUNICIPAL SEWAGE SLUDGE APPLICATION ON GROWTH OF TWO RECLAMATION SHRUB SPECIES IN COPPER MINE SPOILS.**  
Brigham Young Univ., Provo, UT. Dept. of Agronomy and Horticulture.  
B. R. Sabey, R. L. Pendleton, and B. L. Webb.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 580-586, July/September 1990. 7 tab, 46 ref.

Descriptors: \*Bioaccumulation, \*Heavy metals, \*Path of pollutants, \*Plant growth, \*Sludge, \*Sludge utilization, \*Waste disposal, Copper mine spoils, Grasses, Growth rates, Land reclamation, Nutrients, Shrubs, Soil management.

## Sources Of Pollution—Group 5B

Municipal sludge has been used for many years to improve chemical, physical, and biological properties of agricultural soils. One-year old transplants of fourwing saltbush (*Atriplex canescens* (Pursh) Nutt.) and mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana* (Rydb.) Beetle) were grown for 9 mo in large greenhouse pots containing copper mine spoil material amended with one of three rates of municipal sewage sludge. Sludge was thoroughly mixed with the soils in some pots and concentrated around the root plug in others. Additionally, some pots were seeded with western wheatgrass (*Agropyron smithii* Rydb.) to determine whether the presence of grasses would affect shrub response to sludge addition in low pH copper mine spoils. Growth of fourwing saltbush was enhanced from 38-fold to over 300-fold by the addition of sewage sludge. Growth of big sagebrush was increased over six-fold. This was likely the result of increased N, P, and K availability although improved biological and physical properties of the spoil-sludge mix may also have been factors. The addition of western wheatgrass to pots containing fourwing saltbush caused a decrease in shrub growth, undoubtedly due to competition for nutrients and other plant growth factors. At the conclusion of the study, shrub leaves contained high levels of Cd and Pb, reflecting the high Cd and Pb content of the growth medium. Zn, Cu, Mn, and Fe levels were also largely higher than are typical for plant tissue. Shrubs grown in pots in which sludge additions were concentrated around the root plug accumulated more heavy metal than did mixed treatments. Grass tissue did not accumulate excessively high quantities of heavy metals, with the exception of Cu. (Author's abstract) W91-01025

#### ADSORPTION, DEGRADATION, AND PLANT AVAILABILITY OF 2,4-DINITROPHENOL IN SLUDGE-AMENDED CALCAREOUS SOILS.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.  
G. A. O'Connor, R. J. Lujan, and Y. Jin.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 587-593, July/September 1990. 2 fig, 4 tab, 14 ref. U.S. EPA Cooperative Agreement CR-812687-02.

Descriptors: \*Biodegradation, \*Dinitrophenol, \*Fate of pollutants, \*Organic compounds, \*Path of pollutants, \*Sludge, \*Sludge utilization, \*Soil contamination, Adsorption, Calcareous soils, Degradation, Groundwater pollution, Leaching, Plant uptake, Soil treatment.

2,4-Dinitrophenol (DNP) is a moderately weak acid that is expected to be highly labile (leachable and plant available) in high-pH soils. The adsorption and degradation behavior of DNP in two sludge-amended, calcareous soils was determined and used to explain DNP uptake by plants grown in the soils in the greenhouse. The DNP adsorption was minor in both soils and was only slightly affected by sludge. The DNP degradation was rapid in both soils and was unaffected by sludge. Thus, despite limited soil adsorption, plant uptake of DNP was minor in all crops and plant parts owing to rapid soil DNP degradation. Even if a municipal sludge highly contaminated with DNP was identified (an unlikely occurrence), concerns over possible plant contamination should not limit sludge application to calcareous soils at agronomic rates. Rapid degradation will minimize opportunities for plant uptake of DNP from contaminated soils or leaching of DNP to groundwater, given careful water management. (Author's abstract) W91-01026

#### PLANT UPTAKE OF PENTACHLOROPHENOL FROM SLUDGE-AMENDED SOILS.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.  
C. A. Bellin, and G. A. O'Connor.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 598-602, July/September 1990. 1 fig, 1 tab, 21 ref. U.S. EPA Cooperative Agreement CR-812687-02.

Descriptors: \*Bioaccumulation, \*Fate of pollutants, \*Organic compounds, \*Path of pollutants,

\*Pentachlorophenol, \*Plant uptake, \*Sludge, \*Sludge utilization, \*Soil contamination, Alkaline soils, Crops, Degradation, Food chains, Radioisotopes, Soil treatment.

A greenhouse study was conducted to determine the effects of sludge on plant uptake of (C-14)-pentachlorophenol (PCP). Plants included tall fescue (*Festuca arundinacea* Schreb.), lettuce (*Lactuca sativa* L.), carrot (*Daucus carota* L.), and chile pepper (*Capsicum annuum* L.). Minimal intact PCP was detected in the fescue and lettuce by gas chromatography/mass spectrometry (GC/MS) analysis. No intact PCP was detected in carrot tissue extracts. Chile pepper was not analyzed for intact PCP because methylene chloride extracts contained minimal C-14. The GC/MS analysis of soil extracts at harvest suggested a half-life of PCP of about 10 d, independent of sludge rate or PCP loading rate. Rapid degradation of PCP in the soil apparently limited PCP availability to the plant. Bioconcentration factors (dry plant wt/initial soil PCP concentration) based on intact PCP were <0.01 for all crops, suggesting little PCP uptake. Thus, food chain crop PCP uptake in these alkaline soils should not limit land application of sludge. (Author's abstract) W91-01027

#### SORPTION AND DEGRADATION OF PENTACHLOROPHENOL IN SLUDGE-AMENDED SOILS.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.  
C. A. Bellin, G. A. O'Connor, and Y. Jin.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 603-608, July/September 1990. 4 fig, 1 tab, 22 ref. U.S. EPA Cooperative Agreement CR-812687-02.

Descriptors: \*Biodegradation, \*Fate of pollutants, \*Organic compounds, \*Path of pollutants, \*Pentachlorophenol, \*Sludge, \*Sludge utilization, \*Soil contamination, Acidic soils, Alkaline soils, Degradation, Leaching, Radioisotopes, Soil treatment, Sorption.

Sorption and degradation of pentachlorophenol (PCP) by two alkaline and one acid soil was studied in the presence and absence of sewage sludge. The PCP concentrations used (0.1-10 mg/kg) included PCP rates expected with land application of normal municipal sewage sludges. Sorption/desorption isotherms, derived using batch equilibrium techniques, were described by the Freundlich equation. The PCP sorption increased with increasing sludge additions. Desorption in the alkaline soils was completely reversible and no irreversible residues were formed. Leaching of PCP would be most likely in the unamended alkaline soils. Degradation of PCP at low (0.75 mg/kg) initial concentration was rapid (half-life of 10-15 d) in alkaline soils, but much slower (half-life of approximately 38 d) in the acid soils. Sludge additions to the soils did not substantially affect PCP degradation. More rapid degradation of PCP in alkaline vs. acid soils was attributed to less sorption and more favorable conditions for microbial activity. Rapid degradation in the alkaline soil, and greater sorption in the acid soil, reduce the chance of PCP leaching. However, longer PCP residence times in the acid soil increase the possibility for plant uptake. (Author's abstract) W91-01028

#### NITRIFICATION IN SLUDGE-AMENDED MICHIGAN FOREST SOILS.

Michigan State Univ., East Lansing. Dept. of Forestry.  
For primary bibliographic entry see Field 5E.  
W91-01029

#### PRECIPITATION NUTRIENT INPUTS IN SEMIARID ENVIRONMENTS.

Agricultural Research Service, Tucson, AZ. Aridland Watershed Management Research Unit.  
For primary bibliographic entry see Field 2B.  
W91-01030

#### OUTBREAK OF PONTIAC FEVER DUE TO LEGIONELLA ANISA.

Santa Clara County Health Dept., San Jose, CA.  
For primary bibliographic entry see Field 5C.  
W91-01032

#### IDENTIFYING FLOW PATHS IN MODELS OF SURFACE WATER ACIDIFICATION.

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.  
M. B. Beck, F. M. Kleissen, and H. S. Wheater.  
Reviews of Geophysics RVGPB4, Vol. 28, No. 2, p 207-230, May 1990. 18 fig, 1 tab, 36 ref.

Descriptors: \*Acid rain effects, \*Acidic water, \*Acidification, \*Flow models, \*Model studies, \*Path of pollutants, \*Surface water, Coefficients, Flow pattern, Glasgow, Mathematical models, On-site data collections, Scotland, Surface flow, Tracers, Uncertainty.

A clear identification of the movement of water through soils is of central importance to the characterization of surface water acidification. The problem of how a uniquely best set of values for the coefficients of simple models can be estimated from field observations, in particular, tracer observations was explored. Two external observation couples, precipitation/flow and concentrations of a conservative tracer, have been used in the conceptual modeling of the acidification of surface waters. A method for the analysis of model identifiability includes: (1) the postulation of a set of experimental field conditions with their associated assumptions of observation accuracy; (2) the postulation of a model and its associated uncertainties; and (3) the exploration of the identifiability of the model's constituent parameters (hypotheses). A (U.K.) Royal Society's Surface Water Acidification Programme field site situated 40 km north of Glasgow was the subject of an analysis of model uncertainty. For a one-store model, with no observations of the tracer, the proportionality constant,  $k(a)$ , was relatively well identified when first events occurred after dry periods while the accuracy of the estimate progressively declined during wet periods. When observations of the tracer were included,  $k(a)$  was much better identified. For a two-store nonlinear model, tracer observations improved the identifiability of parameters, and the relative identifiability of the model parameters was analyzed. The skill in predicting future behavior in flow paths in a catchment will lie in locating the ambiguity in the model and making predictive statements that are minimally sensitive to it. (MacKeen-PTT) W91-01033

#### ESTIMATION OF AMMONIFICATION AND AMMONIUM ASSIMILATION IN SURFICIAL COASTAL AND ESTUARINE SEDIMENTS.

Tokyo Univ. (Japan). Ocean Research Inst.  
For primary bibliographic entry see Field 2L.  
W91-01035

#### MICROBIAL BIOMASS IN THE COASTAL PLUME OF CHESAPEAKE BAY: PHYTOPLANKTON-BACTERIOPLANKTON RELATIONSHIPS.

Maryland Univ., Cambridge. Center for Environmental and Estuarine Studies.  
For primary bibliographic entry see Field 2L.  
W91-01036

#### PERIODIC BACTERIVORE ACTIVITY BALANCES BACTERIAL GROWTH IN THE MARINE ENVIRONMENT.

Umea Univ. (Sweden). Dept. of Microbiology.  
For primary bibliographic entry see Field 2L.  
W91-01037

#### BIOGEOCHEMISTRY OF CARBON IN THE AMAZON RIVER.

Washington Univ., Seattle. School of Oceanography.  
J. E. Richey, J. I. Hedges, A. H. Devol, P. D. Quay, and R. Victoria.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

Limnology and Oceanography LIOCAH, Vol. 35, No. 2, p 352-371, March 1990. 9 fig, 3 tab, 54 ref. NSF Grants DEB 81-07522 and BSR 83-16359.

Descriptors: \*Amazon River, \*Biochemistry, \*Biogeochemistry, \*Carbon cycle, \*Dissolved organic carbon, \*Geochemistry, \*Nutrients, \*Organic carbon, \*Suspended sediments, Carbon dioxide, Chemical properties, Dissolved oxygen, Dissolved solids, Solute transport.

Depth-integrated, discharge-weighted water samples were collected over 1,800 km of the Amazon River on eight cruises at different stages of the hydrograph, 1982-1984. Fine (FPOC, < 63 microns) and coarse (CPOC, > 63 microns) particulate organic carbon as weight percentage of suspended sediment varied between 0.9-1.5% for FPOC and 0.5-3.4% for CPOC. Concentrations of FPOC ranged from 5 mg/liter upriver to 2 mg/liter downriver in the mainstem and from 6 mg/liter in the Rio Madeira to < 1 in the Rio Negro. CPOC had similar distribution patterns, but with concentrations 15-30% those of FPOC. Dissolved organic carbon (DOC) averaged 4-6 mg/liter in the mainstem and up to 12 mg/liter in the Rio Negro. Upriver dissolved inorganic carbon (DIC) concentrations of about 1,200 micromolar were diluted by tributaries and floodplain drainage to 600 micromolar at the most downriver site. Evasion of CO<sub>2</sub>, invasion of O<sub>2</sub>, and in situ oxidation were of comparable magnitude, 3-8 micromoles/square meter/s. The average export of total organic carbon (TOC) was 36.1 terragrams/yr (8.5 g/square meter/yr), of which 62% was DOC, 34% was FPOC, and 4% was CPOC. TOC inputs were insufficient to support in situ oxidation by a factor of at least two. A relatively small, rapidly cycling pool of labile organic matter may coexist with a much larger pool of more refractory material. (Author's abstract)

W91-01039

#### RAPID AMMONIUM CYCLING AND CONCENTRATION-DEPENDENT PARTITIONING OF AMMONIUM AND PHOSPHATE: IMPLICATIONS FOR CARBON TRANSFER IN FLANKTONIC COMMUNITIES.

Texas Univ. at Austin, Port Aransas. Port Aransas Marine Lab.  
For primary bibliographic entry see Field 2H.  
W91-01043

#### DISTRIBUTION OF LABILE DISSOLVED ORGANIC CARBON IN LAKE MICHIGAN.

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.  
For primary bibliographic entry see Field 2H.  
W91-01044

#### PLASMA CHLOROFORM CONCENTRATIONS IN SWIMMERS USING INDOOR SWIMMING POOLS.

Modena Univ. (Italy). Ist. di Igiene.  
G. Aggazzotti, G. Fantuzzi, P. L. Tartoni, and G. Predieri.  
Archives of Environmental Health AEHLAU, Vol. 45, No. 3, p 175-179, 1 fig, 2 tab, 15 ref, May/June 1990.

Descriptors: \*Chlorination, \*Chloroform, \*Public health, \*Swimming pools, \*Water treatment, Biochemistry, Gas chromatography, Italy, Modena, Recreation, Statistical analysis.

The chloroform content of swimmers and visitors who were exposed to chloroform (CHCl<sub>3</sub>) at three indoor swimming pools in Modena, Italy were evaluated. Chloroform was measured in plasma samples of 127 subjects present at the pools and in 40 nonexposed subjects. The analyses were performed by head-space gas chromatography. Chloroform was present in all samples collected from the 127 subjects who attended the pools (median = 7.5 nmol/L; range = 0.8-25.1 nmol/L). Swimmers who trained for competitions showed a significantly higher mean value of plasma CHCl<sub>3</sub> than nonagonistic swimmers and visitors. Plasma CHCl<sub>3</sub> levels were significantly correlated with:

(1) CHCl<sub>3</sub> concentrations in water and in environmental air; (2) the number of swimmers in the pools, and; (3) the time spent swimming. Covariance analysis showed that plasma CHCl<sub>3</sub> levels also depended on the intensity of the sport activity (total explained variance = 67.4%). (Author's abstract)

W91-01053

#### INVESTIGATION OF THE METAL-ALGAE BINDING SITE WITH 113-CD NUCLEAR MAGNETIC RESONANCE.

Texas Univ. at Austin. Dept. of Chemistry.  
V. Majidi, D. A. Laude, and J. A. Holcombe.  
Environmental Science and Technology ESTHAG, Vol. 24, No. 9, p 1309-1312, September 1990. 4 fig, 15 ref.

Descriptors: \*Algae, \*Bioaccumulation, \*Cadmium, \*Fate of pollutants, \*Heavy metals, \*Nuclear magnetic resonance, \*Path of pollutants, Biochemistry, Cadmium radioisotopes, Cobalt, Copper, Hydrogen ion concentration, Iron, Sodium.

Metal-algae interactions in a unialgal culture (*Stichococcus bacillaris*) were examined with 113-Cd nuclear magnetic resonance (NMR) spectroscopy. In addition to a peak which was attributed to cadmium in solution, a second broad resonance was assigned to cadmium binding with the algal cell wall. Studies of competitive uptake with other metals permit an affinity ranking assigned as Cu, Fe, > Cd, Co, and Na. pH studies indicate that although the presence of protons in the solution does not chemically alter the nature of the binding sites, the excess protons will directly replace the bound Cd. An NMR chemical shift of -10 to -18 ppm for the bound cadmium indicates the functional group responsible for metal uptake is most likely a carboxylic group. The chemical shift of the resonance also suggests the carboxyl groups involved in metal adsorption may possess larger chain lengths and perhaps multiple carboxyl groups per chain. (Author's abstract)

W91-01060

#### VARIATIONS IN SUSPENDED SEDIMENT AND ASSOCIATED TRACE ELEMENT CONCENTRATIONS IN SELECTED RIVERINE CROSS SECTIONS.

Geological Survey, Doraville, GA.  
For primary bibliographic entry see Field 2J.  
W91-01061

#### CADMIUM CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON OF ACIDIFIED AND NONACIDIFIED CANADIAN SHIELD LAKES.

Guelph Univ. (Ontario). Dept. of Zoology.  
N. D. Yan, G. L. Mackie, and P. J. Dillon.  
Environmental Science and Technology ESTHAG, Vol. 24, No. 9, p 1367-1372, September 1990. 2 fig, 3 tab, 41 ref.

Descriptors: \*Acid rain effects, \*Acidic lakes, \*Bioaccumulation, \*Cadmium, \*Limnology, \*Precambrian Shield Lakes, \*Zooplankton, Canada, Crustaceans, Fate of pollutants, Lakes, Ontario, Organic carbon, Path of pollutants, Phosphorus, Plastic Lake, Seasonal variation, Temporal variation.

The cadmium in Epilimnetic zooplankton collected from 33 nonacidified, south central Ontario lakes, most of which were remote from local point sources of Cd emissions, ranged in concentration from 0.16 to 29.8 micrograms/gram of dry weight. Levels were positively correlated with aqueous Cd concentrations and negatively correlated with lake water Ca, organic carbon, and total phosphorus concentrations. A stepwise regression model developed for these lakes overestimated Cd concentrations in zooplankton from acidic (pH < 5), clear water lakes, presumably because the acidity of these lakes depressed Cd uptake. Cd levels varied by 5 fold over the ice-free season in plastic lake, an acidifying lake in south central Ontario. While Cd levels were not correlated with zooplankton composition in the lake survey, temporal variations in Cd levels in Plastic Lake were attributed, in part, to seasonal and annual changes in zooplankton

community structure in the lake. (Author's abstract)

W91-01062

#### MERCURY SPECIATION IN SURFACE FRESHWATER SYSTEMS IN CALIFORNIA AND OTHER AREAS.

California Univ., Santa Cruz. Inst. of Marine Sciences.  
For primary bibliographic entry see Field 2K.  
W91-01063

#### OCCURRENCE, DISTRIBUTIONS, AND TRANSPORT OF HERBICIDES AND THEIR DEGRADATION PRODUCTS IN THE LOWER MISSISSIPPI RIVER AND ITS TRIBUTARIES.

Geological Survey, Denver, CO.  
W. E. Pereira, and C. E. Rostad.  
Environmental Science and Technology ESTHAG, Vol. 24, No. 9, p 1400-1406, September 1990. 5 fig, 3 tab, 16 ref.

Descriptors: \*Herbicides, \*Mississippi River, \*Path of pollutants, Agricultural runoff, Alachlor, Atrazine, Chemical analysis, Chlorinated hydrocarbons, Chloroacetaldehyde, Cyanazine, Gulf of Mexico, Metolachlor, Pollution load, Simazine, Triazines.

The Mississippi River and its tributaries drain extensive agricultural regions of the mid-continental US where large amounts of herbicides are applied as weed control agents on crops such as corn and soybeans. Studies being conducted by the US Geological Survey (USGS) along the lower Mississippi River and its major tributaries, representing a 1930-km river reach, have confirmed that several triazine and chloroacetaldehyde herbicides and their degradation products are present in this riverine system. These herbicides include atrazine, and its degradation products, desisopropylatrazine; cyanazine; simazine; metolachlor; and alachlor and its degradation products, 2-chloro-2',6'-diethylacetaldehyde, and 2-hydroxy-2',6'-diethylacetaldehyde. Loads of these compounds were determined at 17 different sampling stations under various seasonal and hydrologic conditions, during five sampling trips from July 1987 to June 1989. Stream loads of herbicides were relatively small during the drought of 1987 and 1988. Stream loads were much greater during the relatively wet year of 1989. Trace levels of atrazine, cyanazine, and metolachlor also were associated with suspended sediments. Distribution coefficients of these compounds varied considerably between sites and were much larger than values reported in the literature. The annual transport of atrazine into the Gulf of Mexico was estimated to be less than 2% of the amount of atrazine applied each year in the mid-west. (Author's abstract)

W91-01064

#### ENVIRONMENTAL FACTORS AFFECTING THE PRODUCTION OF PEPTIDE TOXINS IN FLOATING SCUMS OF THE CYANOBACTERIUM MICROCYSTIS AERUGINOSA IN A HYPERTROPHIC AFRICAN RESERVOIR.

Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.  
For primary bibliographic entry see Field 2H.  
W91-01065

#### POLYCYCLIC AROMATIC HYDROCARBON EMISSIONS FROM THE COMBUSTION OF CRUDE OIL ON WATER.

National Inst. of Standards and Technology (NIST), Gaithersburg, MD.  
B. A. Benner, N. P. Bryner, S. A. Wise, G. W. Mulholland, and R. C. Lao.  
Environmental and Planning B. Planning & Design, Vol. 17, No. 1, p 1418-1427, 1990. 6 fig, 6 tab, 25 ref.

Descriptors: \*Cleanup operations, \*Environmental effects, \*Incineration, \*Oil pollution, \*Polycyclic aromatic hydrocarbons, \*Water pollution sources, \*Water pollution treatment, Air pollution, Chemical analysis, In situ treatment, Organic carbon.

## Sources Of Pollution—Group 5B

An investigation was conducted concerning some of the factors necessary to assess the environmental impact of an in situ burn: the fraction of an oil layer that can be burned, the quantity of smoke, and the concentrations of 18 polycyclic aromatic hydrocarbons (PAHs) in the smoke, crude oil, and burn residue. Alberta Sweet crude in 2-, 3-, 5, 10, and 30-mm layers on water was burned and smoke samples were collected at elevated and ambient temperatures and analyzed by two independent laboratories. While burning the crude oil produced less total PAHs than were in the original crude oil, the concentrations of PAHs with five or more rings were 10 to 20 times greater in the smoke than in the oil. The organic carbon fraction of the smoke was in the range of 14-21%. As the fuel layer thickness was increased from 2 to 10 mm, the smoke yield increased from 0.035 to 0.080 g of smoke/g of fuel, and the percentage of oil residue decreased from 46 to 17%. By consuming much of the oil spill and reducing the amount of PAHs in the water, and by dispersing the combustion products over a larger area, in situ burning can migrate the local environmental impact of an oil spill. There appears to be a range of conditions, such as in Arctic ice fields, where in situ burning might be the most viable cleanup method. (Author's abstract)

W91-01066

# CHEMICAL AND PHYSICAL SPECIATION OF TRACE METALS IN FINE GRAINED OVERBANK FLOOD SEDIMENTS IN THE TYNE BASIN, NORTH-EAST ENGLAND.

Newcastle upon Tyne Univ. (England). Dept. of Geography.  
M. G. Macklin, and R. B. Dowsett.  
Catena, Vol. 16, No. 4/5, p 135-151, August/October 1989. 8 fig, 1 tab, 24 ref.

Descriptors: \*Chemical speciation, \*England, \*Flood plain sediments, \*Heavy metals, \*Path of pollutants, \*Sedimentation, \*Speciation, \*Trace metals, Contamination, Metal complexes, Tyne Basin, Water pollution.

Deposition of fine sediment contaminated by heavy metals on floodplains in the Tyne Basin, north-east England, during a major flood in August 1986 provided an unusual opportunity to investigate the physical and chemical speciation of metals in overbank fines. Selective extractions and heavy-liquid analyses were used to assess the chemical forms of sediment-associated metal and the relationship between grain size, density and metal concentration and to identify sources of metaliferous material. Generally the highest concentrations of trace metals were found in the 500-250 microm size range and in the heavier density fractions (> 3.3 g/ml), though more than 60% of metals reported to the lightest (< 3.3 g/ml) density product. The principal source of metals appeared to be reworked alluvium contaminated by historic mining activity. Metals concentrations in flood sediment decrease downstream from former mining areas at varying rates depending on the physical properties and chemical phase of individual metals. With the exception of copper (dominated by lithogenic fraction), metals are primarily associated with iron/manganese oxides (lead, zinc) and to a lesser extent with carbonates (cadmium, zinc), organic matter (zinc, copper) and an operationally defined exchangeable cadmium component. In the upper and middle parts of the Tyne basin physical processes of downstream sediment metal content reduction were found to predominate, while in the lower reaches of the Tyne sediment metal transport appears to be governed by chemical sorption-desorption processes associated with iron/manganese oxides and organic material. Before employing sediment-density based dispersal models to predict downstream metal concentrations, grain size and density fractions must be ascertained for the majority of sediment-associated metals, and their chemical form as revealed by selective extraction techniques. (Brunone-PTT)

W91-01082

# HYDROGEOLOGY AND HISTORICAL ASSESSMENT OF A CLASSIC SEQUENTIAL-LAND USE LANDFILL SITE, ILLINOIS, USA.

Northern Illinois Univ., De Kalb. Dept. of Geology.  
For primary bibliographic entry see Field 5F.  
W91-01097

**HEAVY METAL DISTRIBUTION IN SEDIMENTS OF KRISHNA RIVER BASIN, INDIA.**  
McGill Univ., Montreal (Quebec). Dept. of Geological Science.  
R. Ramesh, V. Subramanian, and R. Van Grieken.  
Environmental Geology and Water Sciences EGWSEI, Vol. 15, No. 3, p 207-216, May/June 1990. 5 fig, 6 tab, 30 ref.

Descriptors: \*Heavy metals, \*India, \*Krishna River, \*Path of pollutants, \*Suspended sediments, Topography, Trace metals, Water pollution, X-ray fluorescence.

Suspended and bed sediments collected from the entire region of the Krishna River and its major tributaries were analyzed for heavy metals (vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, and lead) by the thin-film energy dispersive x-ray fluorescence technique. There is considerable variation in the concentration of elements proceeding downstream, which may be due to the variation in the subbasin geology and various degrees of human impact. Suspended particles have high concentrations of heavy metals throughout the basin bed sediments. The heavy metals are highest in coarse size fractions (10 to 90 microm) throughout the Krishna River except for the Bhima tributary where finer fractions (2 microm) dominate. Transition elements correlate very well with each other. There is a striking similarity between the bed sediments of Krishna River and the average for Indian rivers. When the annual heavy metal flux carried by the Krishna River was estimated, and viewed in relation to the other major riverine transport, the Krishna appears to be a minor contributor of heavy metals to the Bay of Bengal. (Author's abstract)

W91-01100

**ENFORCEMENT OF FEDERAL UNDERGROUND STORAGE TANK REGULATIONS.**  
North Carolina Univ. at Wilmington. Dept. of Philosophy.  
For primary bibliographic entry see Field 5G.  
W91-01103

**INTERACTION BETWEEN COMPONENTS OF ELECTROPLATING INDUSTRY WASTES, INFLUENCE OF THE RECEIVING WATER ON THE TOXICITY OF THE EFFLUENT.**  
Institut National de la Sante et de la Recherche Medicale, Villeneuve d'Ascq (France). Microbe Ecotoxicology Unit 146.  
For primary bibliographic entry see Field 5C.  
W91-01106

**PHOSPHORUS IN WATERS FROM SEWAGE SLUDGE AMENDED LYSIMETERS.**  
Illinois Univ., Urbana. Dept. of Agronomy.  
T. D. Hinesly, and R. L. Jones.  
Environmental Pollution ENPOEK, Vol. 65, No. 4, p 293-309, 1990. 6 tab, 17 ref.

Descriptors: \*Lysimeters, \*Path of pollutants, \*Phosphorus, \*Sludge utilization, \*Soil amendments, \*Soil-water-plant relationships, Aluminum, Corn, Eutrophication, Fertilizers, Iron, Runoff, Tile drainage.

In surface waters, phosphorus (P) concentrations exceeding 0.05 mg/L may cause eutrophic conditions. Total P concentrations were measured in runoff and tile drainage waters from land receiving either inorganic fertilizer or anaerobically digested sewage sludge during two years of sample collections from instrumented, large-scale lysimeters planted to corn (Zea mays). During the three years prior to monitoring P concentrations, six of the lysimeter plots had been amended with anaerobically digested sewage sludge which supplied 5033 kg P per ha. Additional sludge applications supplied 1058 and 1989 kg P per ha during the first and second years of monitoring operations. An-

other six lysimeters were annually treated with fertilizer which included P applications amounting to 112 kg per ha. For years 1 and 2, annual losses from lysimeters treated with sewage sludge were 4.27 and 0.35 kg P per ha in runoff and 0.91 and 0.51 kg P per ha in drainage waters. Parallel annual losses of P from lysimeters treated with superphosphate were 2.15 and 0.17 kg P per ha in runoff and 0.53 and 0.35 kg P per ha in tile drainage waters. Sludge applications did not significantly change absolute soil contents of organic P, but did decrease the percent of total P present in organic forms. Sludge and soil contained 21% and 36% of their total P contents in organic forms. In sludge and soil about 85% and 64% of their respective total inorganic P contents were associated with the Al and Fe fractions. Sludge applications significantly increased soil contents of P in the saloid aluminum, iron and reductant soluble P fractions, but contents of calcium-bound P were not changed. Total P contents of the soil below a depth of 30 cm were not affected by sludge incorporated to a depth of about 15 cm by plowing. (Author's abstract)

W91-01107

# GREEN OYSTERS CAUSED BY COPPER POLLUTION ON THE TAIWAN COAST.

National Taiwan Univ., Taipei. Inst. of Oceanography.  
For primary bibliographic entry see Field 5C.  
W91-01108

**BIOACCUMULATION AND TOXICITY OF ZINC IN THE GREEN ALGA, CLADOPHORA GLOMERATA.**  
Polytechnic of Central London (England). Applied Ecology Research Group.  
For primary bibliographic entry see Field 5C.  
W91-01111

**DENITRIFICATION IN NITRATE-RICH STREAMS: DIURNAL AND SEASONAL VARIATION RELATED TO BENTHIC OXYGEN METABOLISM.**  
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.  
For primary bibliographic entry see Field 2H.  
W91-01142

**COMPARISON OF THE ACIDIFICATION EFFICIENCIES OF NITRIC AND SULFURIC ACIDS BY TWO WHOLE-LAKE ADDITION EXPERIMENTS.**  
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.  
J. W. M. Rudd, C. A. Kelly, D. W. Schindler, and M. A. Turner.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 663-679, May 1990. 7 fig, 4 tab, 58 ref.  
Dept. of Fisheries and Oceans, Govt. of Canada and NSERC Grants A2671 and OGP GP 010.

Descriptors: \*Acid rain, \*Acid rain effects, \*Denitrification, \*Lake acidification, \*Limnology, \*Nitric acid, \*Sulfuric acid, Algal uptake, Sediment-water interfaces.

The acidification efficiencies of nitric and sulfuric acids were compared for 5 yr by separate experimental additions of the acids to the partitioned north and south basins of Lake 302. In the epilimnion, nitric acid was 70% as efficient as sulfuric acid in reducing alkalinity. On a whole-lake basis, acidification by nitric acid was about half as efficient as by sulfuric acid. In-lake processes removed 70 and 57% of the added nitric and sulfuric acids. Before acidification, algal uptake and sediment sulfate uptake were of about equal importance in terms of in-lake sulfate removal. Nitrate was primarily removed by algal uptake and sedimentation. After acidification, algal uptake of nitrate and sulfate did not change, but rates of uptake in the sediments by bacterial processes increased and dominated in-lake removal. Nitric acid acidified the north basin because the acid additions exceeded the capacity of all biological removal processes. Algal uptake and sedimentation of nitrogen could

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

not increase in proportion to increases in nitrate because of P limitation. Sediment-denitrification rates increased tremendously (about 40-fold) but only removed a portion of the incoming nitrate because denitrification was limited by the rate of transport to the sediment-water interface. (Author's abstract)  
W91-01143

#### MIXING IN OVERLAND FLOW DURING RAINFALL

Missouri Univ.-Columbia. Dept. of Civil Engineering. R. L. Peyton, and T. G. Sanders. Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 4, p 764-784, July/August 1990. 11 fig, 1 tab, 27 ref.

Descriptors: \*Mathematical models, \*Mixing, \*Model studies, \*Nonpoint pollution sources, \*Overland flow, \*Path of pollutants, \*Rainfall-runoff relationships, \*Water pollution sources, Convection, Data interpretation, Rainfall, Reynolds number, Turbulent flow.

Vertical mixing coefficients in overland flow is estimated with rainfall using laboratory data and a mathematical model of shear-flow convection, rainfall dilution and vertical mixing. The laboratory data consist of concentration-time measurements downstream from an injection of a conservative dye. The dye was injected into overland flow (during rainfall) over a smooth impervious surface with constant slope and without sediment. The flow is in the laminar Reynolds number range. Results of the mathematical model were compared to the concentration-time measurements to calibrate values of the vertical mixing coefficient. The calibrated values of the vertical mixing coefficient are most highly correlated to the slope and a Reynolds number related to rainfall intensity. An analysis of the calibrated vertical mixing coefficient values using equations for eddy turbulence did not prove satisfactory. (Author's abstract)  
W91-01153

#### MERCURY CONTENT OF SWORDFISH, XIPHIAS GLADIUS, IN RELATION TO LENGTH, WEIGHT, AGE, AND SEX

Universidade dos Açores, Horta (Portugal). Dept. de Oceanografia e Pescas. L. R. Monteiro, and H. D. Lopes. Marine Pollution Bulletin MPNBZ, Vol. 21, No. 6, p 293-296, June 1990. 4 fig, 3 tab, 28 ref.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Mercury, \*Swordfish, Heavy metals, Marine pollution, Water quality.

Levels of total mercury were determined in the white muscle tissue of swordfish, *Xiphias gladius* L., caught in the Azores, ranging in weight from 0.06 to 4.91 microgm/g. Mercury concentrations were studied in relation to length, weight, age and sex and significant sex-based differences were found. The rate of mercury accumulation in males is significantly faster than in females, and for medium-large sized fish, mean mercury levels were higher in males. The mean mercury level in males was 1.3 microgm Hg/g and 0.93 microgm Hg/g for females. Possible explanations involve the consideration of specific mechanisms of mercury elimination in females due to a different chemistry of gonad and gamete affecting the affinity of mercury and loss of residues in the sex products. Or, to a simple difference in the total amount of sperm and ova shed. Swordfish were shown to have a concentration factor of 300 compared to plankton. (King-PTT)  
W91-01160

#### TISSUE DISTRIBUTION OF HEAVY METALS IN SMALL CETACEANS FROM THE SOUTHWESTERN ATLANTIC OCEAN

Instituto Nacional de Investigacion y Desarrollo Pesquero, Mar del Plata (Argentina). J. E. Marcovecchio, V. J. Moreno, R. O. Bastida, M. S. Gerpe, and D. H. Rodriguez. Marine Pollution Bulletin MPNBZ, Vol. 21, No. 6, p 299-304, June 1990. 2 fig, 4 tab, 32 ref.

Descriptors: \*Bioaccumulation, \*Heavy metals, \*Marine mammals, \*Marine pollution, \*Path of pollutants, Bioindicators, Bottlenose dolphins, Cetaceans, Copper, Ecosystems, Fate of pollutants, Mammals, Mercury, Pollutant identification, Tissue analysis, Whales, Zinc.

Tissue distribution of heavy metals, total mercury, cadmium, zinc, and copper, in specimens of Bottlenose Dolphin (*Tursiops geophyus*), Franciscana Dolphin (*Pontoporia blainvillei*), and Pigmy Sperm Whale (*Kogia breviceps*) stranded on SW Atlantic beaches were studied by atomic absorption spectrophotometry. The liver was the most important site for the accumulation of Hg, Zn, and Cu in the specimens studied while the kidney was most important for Cd accumulation. Mercury contamination in *Tursiops geophyus* increased with age, and therefore, correlated with its ichthyophagous habits. The Franciscana had lower mercury levels than the bottlenose because of their younger ages and a diet which is heavier in squid and crustaceans. Also, mercury levels were higher in the muscle tissues of Franciscana than in their livers. The Franciscana can stay in very saline waters and their ability to maintain a salt balance may help to detoxify their livers. Maximum mercury concentrations in the pigmy sperm whales was 11.74 ppm, well below the level found in the Bottlenose Dolphin. The sperm whales were adults so this lower Hg level was probably the result of their diet of squid. The highest Cd, Zn and Cu levels were found in the kidneys of all three species. (King-PTT)  
W91-01162

#### MERCURY NEAR A CAUSTIC SODA PLANT AT KARWAR, INDIA

Central Marine Fisheries Research Inst., Cochin (India). P. K. Krishnakumar, and V. K. Pillai. Marine Pollution Bulletin MPNBZ, Vol. 21, No. 6, p 304-307, June 1990. 2 fig, 2 tab, 13 ref.

Descriptors: \*India, \*Karwar, \*Marine pollution, \*Mercury, \*Path of pollutants, Arabian Sea, Atomic absorption spectrophotometry, Bioaccumulation, Chlorine, Heavy metals, Mackerel, Marine sediments, Pollutant identification, Sodium hydroxide, Water pollution sources, Water quality.

Every year 180 tons of mercury are added to the Indian environment, of which 160 tons comes from 38 caustic soda plants including 23 units which electrolyze sea water. A caustic soda plant has been in operation south of Karwar, India since 1975. This plant discharges into the Binage Bay, known for its mackerel fishery. In February 1989, samples of surface water and bottom water were taken from four stations near the discharge point of the caustic soda plant. Surface sediment samples were collected from 10 stations from September 1987 to May 1988. Samples of mussels, oyster and seaweed were taken from 12 stations along the Karwar coast from September 1987 to February 1989. Fish, prawn, crab, and squid samples were taken from commercial landings in Karwar. Mercury was determined by cold vapor atomic absorption spectrophotometry. The mercury concentration in the vicinity of the discharge was 0.91 microgm/g to 2.62 microgm/g compared to the 0.061 microgm/g average concentration in the Arabian Sea. Levels were higher for surface water than bottom water. Mercury levels were highest in oysters and second highest in mussels, seaweed, and in order of declining concentration mackerel, prawn, crab, squid, and sardine. (King-PTT)  
W91-01163

#### HEAVY METAL CONCENTRATION IN TELESCOPIUM FROM DARWIN HARBOUR, N.T., AUSTRALIA

Northern Territory Univ., Darwin (Australia). School of Chemistry. For primary bibliographic entry see Field 5A.  
W91-01164

#### ESTIMATING THE EFFECTS OF DISPERSED ORGANIC POLYMERS ON THE SORPTION OF CONTAMINANTS BY NATURAL SOLIDS

#### 2. SORPTION IN THE PRESENCE OF HUMIC AND OTHER NATURAL MACROMOLECULES

Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.

Y. P. Chin, W. J. Weber, and B. J. Eadle. Environmental Science and Technology ESTHAG, Vol. 24, No. 6, p 837-842, June 1990. 11 fig, 1 tab, 21 ref. Michigan Sea Grant Project R/TS-29 under NOAA Sea Grant NA86AA-O-SG043 and NSF Project ECE-8503903.

Descriptors: \*Humic substances, \*Organic pollutants, \*Path of pollutants, \*Sorption, Lake sediments, Model studies, Natural waters, Polymers, Synergistic effects.

Complex and dynamic interactions are known to occur between organic micropollutants, solid phases, and dispersed polymer subphases present in natural waters. In this study, a triphase distribution model was used in conjunction with experimental analyses to characterize the effects of humic polymers dispersed in an aqueous phase on the sorption of hydrophobic organic compounds from that phase by natural solids. The results indicate that the sorption of moderately hydrophobic compounds by lacustrine sediments is relatively unaffected by the presence of humic polymers, whereas the sorption of highly insoluble organic contaminants by the same sorbents is sensitive to small amounts of background organic polymers. These data support the reports of others regarding the extent of the impact of organic subphases on the fate and transport of pollutants in natural aquatic systems. (D'Agostino-PTT)  
W91-01180

#### GEOCHRONOLOGY FOR POLYCYCLIC AROMATIC HYDROCARBON CONTAMINATION IN SEDIMENTS OF THE SAGUENAY FIORD

Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Dept. of Fisheries and Oceans. J. N. Smith, and E. M. Levy.

Environmental Science and Technology ESTHAG, Vol. 24, No. 6, p 874-879, June 1990. 7 fig, 20 ref.

Descriptors: \*Aluminum, \*Path of pollutants, \*Polycyclic aromatic hydrocarbons, \*Sediment contamination, \*Sediment distribution, Carcinogens, Estuarine sediments, Fluvial sediments, Quebec, Scavenging.

Of the wide range of environmental organic contaminants, polycyclic hydrocarbons (PAHs) are of particular concern due to their potential or proven carcinogenicity. After entering the environment, mainly by the combustion of organic materials, they are widely disseminated by fluvial and aeolian pathways and eventually accumulate in soils and sediments. Combined atmospheric/fluvial transport and deposition data indicate that the PAH concentrations and sediment fluxes of the Saguenay Fjord, Quebec, are directly accounted for by concurrent developments in the region's aluminum industry. In addition, the linear relationship observed between PAH and organic matter concentrations suggests that scavenging from the water column may be the dominant mechanism for PAH deposition. (D'Agostino-PTT)  
W91-01183

#### CONTAMINATION OF BAVARIAN LAKES AFTER THE CHERNOBYL REACTOR ACCIDENT: A TWO-COMPARTMENT MODEL ANALYSIS

Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.). W. Sanger, and K. Hubel.

Health Physics HLTPAO, Vol. 58, No. 5, p 649-653, May 1990. 4 fig, 2 tab, 6 ref. Research project St.Sch.1.071, German Federal Ministry of the Environment.

Descriptors: \*Chernobyl, \*Mathematical models, \*Nuclear accidents, \*Nuclear reactors, \*Path of pollutants, \*Radioecology, Gamma radiation, Lakes, Surface water, Contamination.

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Almost immediately following the reactor incident in Chernobyl in 1986, the short-lived radionuclides  $^{103}\text{Ru}$ ,  $^{131}\text{I}$ , and  $^{132}\text{Te}$ , along with the longer-lived nuclides  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  were washed out by rainfall into the South Bavarian lakes. Shortly after, the Bavarian Agency for Water Research assessed the contamination by spectral measurement of the gamma radiation in unfiltered lake water surface samples. For all lakes and radionuclides examined, decomposition analysis using a mathematical two-compartment model indicated that the activity concentration changed from a rapid decrease, from initially high values, to an approximately 10 times slower decrease in a time-dependent manner. These data demonstrate a time-dependent dispersion of contaminating radionuclides in surface waters. (D'Agostino-PTT) W91-01185

## ASSOCIATION OF SHOWER USE WITH LEGIONNAIRES' DISEASE.

Center for Infectious Diseases, Atlanta, GA. Div. of Bacterial Diseases.

R. F. Breiman, B. S. Fields, G. N. Sanden, L. Volmer, and A. Meier.  
JAMA: Journal of the American Medical Association JAMAAP, Vol. 263, No. 21, p 2924-2926, June 1990. 3 tab, 25 ref.

Descriptors: \*Aerosols, \*Amebas, \*Bathing, \*Human diseases, \*Legionella, Bacterial analysis, Epidemiology, Potable water, Water analysis.

Prevention of Legionnaires' Disease (LD) has so far been limited due to a lack of understanding of the ecology of the causative agent, *Legionella pneumophila*. In a lengthy outbreak of nosocomial LD at a South Dakota hospital both the epidemiologic and laboratory data implicated the aerosolized shower water as the vehicle for disease transmission. In addition, the presence of amoebae at the implicated potable water sites correlated directly with the presence of the epidemic strain of *Legionella pneumophila*. The combined evidence suggests that the amoebae serve as reservoirs and provide the bacteria with an intracellular environment for multiplication. Recognition of this interrelationship between amoebae and *L. pneumophila* may lead to new disinfection methods and subsequent disease prevention. (D'Agostino-PTT) W91-01186

## MODELING STUDIES FOR THE CITY OF AUSTIN STORMWATER MONITORING PROGRAMS.

Austin Environmental Protection Dept., TX.  
For primary bibliographic entry see Field 4C.  
W91-01194

## FREQUENCY ANALYSIS OF TRACE LEVEL WATER QUALITY DATA WITH A TIME VARYING CENSORING LEVEL.

Merrick and Co., Denver, CO.  
S. R. Durran.  
IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 92-101, 1 fig, 7 ref.

Descriptors: \*Frequency analysis, \*Statistical analysis, \*Trace levels, \*Urban hydrology, \*Urban runoff, \*Water quality, Data interpretation, Pollutant identification, Regression analysis, Statistical methods.

Databases representing measurements of trace level contaminant concentrations are often censored by a constraint on the range over which measurements can be made. Technology is such that there is often a detection limit below which contaminant concentrations can not be measured and as a result, databases can be proliferated with entries such as 'undetectable' or 'less than detection limit'. A number of recent studies have addressed the frequency analysis of censored data sets but have all been limited to the special case where the detection limit is constant over time. Statistical methods such as regression techniques and the method of maximum likelihood are intended to be applied to the lognormal distribution, but may also

be applied to the normal distribution. The implications of the comparison between these two methods appears to be significant. The regression approach, because of its relative simplicity, is probably the most frequently applied of the two estimation techniques. This method has previously been shown to be comparable to the maximum likelihood technique and its use has thus been justified. A qualification must now be imposed on the statement of comparability however. Previous studies have all addressed the special case of a time invariant censoring level rather than the more general situation presented here. While the regression technique might perform well in the special case, it fails in the general case since not even all of the non-censored data values can be utilized. The method of maximum likelihood, on the other hand, makes use of all observed data, including that which is censored, and thus serves to maximize the benefit that is afforded by a reduced censoring level. (See also W91-01188) (Lantz-PTT) W91-01198

## USE OF A COMPARTMENTAL MODEL TO DEVELOP RULES FOR THE INTERPRETATION OF WATER QUALITY DATA.

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.

J. P. Lumbers, and S. J. Wishart.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 147-158, 8 fig, 19 ref.

Descriptors: \*Ammonia, \*Data interpretation, \*Expert systems, \*Fish physiology, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Toxicity, Fisheries, Performance evaluation, Water pollution prevention, Water quality.

A mathematical model was used to investigate the toxicity of fluctuating ammonia concentrations to freshwater fish. The effects of varying ammonia concentrations over time were integrated in a compartmental model designed to simulate the uptake and depuration of ammonia and its transport within the organism to a critical site. Adjustment of parameter values to allow for acclimation and other modifying factors was examined. The performance of the model was compared with published LC50-exposure curves and experimental evidence of the response of fish to varying ammonia concentrations. An immediate difficulty in the use of the compartmental model was a lack of direct observations of ammonia concentration in blood plasma and intracellular fluid which may be used to estimate the values of the rate constants incorporated in the model. Results are presented for the simulated response to synthetic time-series of ammonia in the environment. These results may be used for the control of fluctuating pollutant concentrations in response to water quality standards. The model may be used to derive permissible magnitude-duration-frequency combinations for pollution events. The compartment model could be used within an expert system during each interpretation or outside the expert system to derive rules to be written into the knowledge base. (See also W91-01211) (Geiger-PTT) W91-01214

## CYANOBACTERIAL TOXINS IN EUROPEAN WATERS: OCCURRENCE, PROPERTIES, PROBLEMS AND REQUIREMENTS.

Dundee Univ. (Scotland). Dept. of Biological Sciences.

G. A. Codd, W. P. Brooks, L. A. Lawton, and K. A. Beattie.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 211-220, 4 tab, 54 ref.

Descriptors: \*Algal blooms, \*Cyanophyta, \*Eutrophication, \*Path of pollutants, \*Phosphorus removal, \*Toxins, Aquatic bacteria, Europe, Monitoring, Pollutant identification, Water quality standards.

The cyanobacteria (blue-green algae) which commonly occur as massive growths in nutrient-enriched European freshwaters typically belong to groups which can produce toxins. Toxic cyanobacteria have long been recognized as causative agents of animal, bird and fish kills and evidence exists for their adverse effects on human health. Cyanobacterial toxins also have adverse effects on zooplankton and can be accumulated by shellfish. Toxic cyanobacterial blooms have been recorded from at least 16 European countries and their toxins have been detected in over 50% of the samples collected (>200) in Europe. Toxin-forming genera include *Microcystis*, *Anabaena*, *Anabaenopsis*, *Aphanizomenon*, *Oscillatoria*, *Nodularia*, *Gloeotrichia*, *Coleosphaeria*, *Gomphosphaeria*, *Lyngbya*, *Schizothrix*, *Cylindrospermopsis*, and *Nostoc*. The toxins include hepatotoxic cyclic 7-and 5-amino acid peptides, neurotoxic alkaloids, phenolics, lipopolysaccharides and others as yet uncharacterized. Cyanobacterial toxin detection and quantification has relied upon mouse bioassays until recently although chromatographic-, cytotoxicity-, and immunoassays are now available. Cyanobacterial toxin production has been successfully regulated by reducing phosphorus inputs to water sources. Monitoring of bacterial scums for cyanobacterial toxins should be done in a timely manner as scums may appear and disappear quite rapidly. Water columns should also be sampled due to the ability of cyanobacteria to stratify in a water source. The widespread occurrence of toxic cyanobacteria in eutrophic European freshwaters and the hazard which they pose to human health indicate the need for guidelines for freshwater containing these toxins and standards if such sources are for drinking. (See also W91-01211) (Author's abstract) W91-01221

## CONTAMINATION OF POTABLE WATER BY CORROSION OF TIN-LEAD SOLDERED JOINTS.

Surrey Univ., Guildford (England). Dept. of Materials Science and Engineering.

R. Walker, and R. J. Oliphant.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 221-228, 1 fig, 6 tab, 17 ref.

Descriptors: \*Corrosion, \*Lead, \*Potable water, \*Public health, \*Tin, \*Water conveyance, \*Water pollution effects, Chlorides, Drinking water, England, Hydrogen ion concentration, Pipes, Silicates, Sulfates, Water pollution prevention, Zinc.

A survey of houses in Great Britain in 1977 found that 9% of homes had a lead content in domestic water in excess of 0.1 mg/L and 20% over 0.05 mg/L in the first draw sample of water remaining in pipes overnight. This compares unfavorably with the report of the Commission of European Communities which in 1980 gave a level of lead of 0.05 mg/L for a sample of running water as the maximum admissible concentration with the rider that where samples either frequently or to an appreciable extent exceed 0.1 mg/L, suitable measures must be taken to reduce the exposure to lead on the part of the consumer. This concentration of lead in water can arise from the corrosion of tin-lead solders in copper water pipes. A galvanic corrosion cell was designed and used to quantitatively assess the effects of various water quality parameters on corrosion rates of the solder. The main features stimulating corrosion were found to be low pH (high acidity) and high concentration of chloride. Fortunately the presence of sulfate, silicate and zinc were shown to inhibit corrosion; the zinc originated from the zinc chlorides used as an active ingredient in the flux used in soldering. Carbonate hardness and orthophosphate had no effect on the corrosion rate. Only by limiting the area of solder exposed in the bore of the tube could a significant long-term problem be avoided. The only sure way to avoid contamination is to specify lead-free solders. (See also W91-01211) (Author's abstract) W91-01222

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

#### CONSTRAINTS ON THE USE OF MODELS TO PREDICT THE MOVEMENT OF PESTICIDES TO GROUNDWATER.

R. J. Hance, and J. A. Guth.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 229-237, 33 ref.

Descriptors: \*Error analysis, \*Groundwater pollution, \*Mathematical models, \*Nonpoint pollution sources, \*Path of pollutants, \*Pesticides, \*Water pollution sources, Adsorption, Herbicides, Pesticide kinetics, Prediction, Sampling.

Movement of a pesticide from soil to groundwater is affected by the properties of the chemical, the way in which it is used, the hydraulic properties of the soil and the hydrogeology of the region. These factors interact so they must all be considered if a realistic prediction is to be obtained. Currently available models for predicting groundwater contamination by pesticides involve simplifications of many, if not all, of the processes which are involved and often ignore some factors altogether. This is partly because of the complexity of the systems and partly because of a lack of appropriate data. Variability in the reported properties of pesticides, together with problems in measuring low concentrations and in sampling, make it difficult to validate models in the field so they are of limited value for predicting pesticide behavior. (See also W91-01211) (Author's abstract)  
W91-01223

#### WELL-WATER METHAEMOGLOBINAEMIA: THE BACTERIAL FACTOR.

Norsk Hydro, Porsgrunn. Research Centre.  
For primary bibliographic entry see Field 5C.  
W91-01224

#### VIROLOGICAL QUALITY OF BATHING WATERS IN ENGLAND.

Severn-Trent Labs., Coventry (England).  
R. Morris, and I. Cox.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 337-343, 3 fig, 3 tab, 18 ref.

Descriptors: \*England, \*Enteroviruses, \*Swimming, \*Water quality, \*Water quality standards, Bacteria, Beaches, Coliforms, Pollutant identification, Recreation, Viruses, Water analysis, Water quality control.

The European Community (EC) bathing water directive includes a recommendation that waters at EC-designated bathing areas should be examined for the presence of enteroviruses whenever there are grounds for suspecting a deterioration in quality. In the United Kingdom this has been interpreted as being a response to the failure of bathing waters to satisfy the bacteriological requirements of the directive. The current U.K. practice is to examine two samples for enteroviruses in the recognized bathing season (May to September) when the water has failed bacteriologically in the previous year. In addition, the U.K. interpretation of the directive applies only to marine waters and, at this time, does not include any inland waters. In an examination of the virological data made available by many of the U.K. water authorities, the bodies currently responsible for bathing water quality, 48% of locations tested for the presence of enteroviruses in 1988 satisfied the requirements of the directive. However, of those failing to meet the enterovirus standard, 41% failed on only one sampling occasion while the remainder (11%) failed on at least two occasions. The highest level of enterovirus contamination detected was 206 plaque-forming units in a 10 liter sample. (See also W91-01211) (Author's abstract)  
W91-01235

#### INCIDENCE OF ENTEROVIRUSES AROUND THE WELSH COAST: A THREE YEAR INTENSIVE SURVEY.

Welsh Water Authority, Bridgend.  
H. Merrett, C. Pattinson, C. Stackhouse, and S. Cameron.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 345-351, 2 fig, 2 tab, 23 ref.

Descriptors: \*Bioindicators, \*Coliforms, \*Enteroviruses, \*Viruses, \*Wales, \*Water quality, \*Water quality standards, Beaches, Monitoring, Pollutant identification, Public health, Recreation, Swimming, Water analysis, Water pollution sources, Water quality control.

The incidence of enteroviruses in 48 bathing waters around the Welsh coast was assessed during the period 1986-1988 as part of the routine compliance monitoring programme for European Community bathing waters. Out of a total of 623 samples taken, 168 (27%) were positive for enteroviruses and the number of virus particles in the samples ranged from 1-23 plaque-forming units/10 L water. Generally, the incidence of viruses in bathing waters adjacent to areas of high population density was higher than that in bathing waters far removed from these areas. However, viruses were also isolated from waters with no significant sewage input and where contamination by sewage material as estimated by the *Escherichia coli*/total coliform count was minimal. There was no correlation between the presence of enteroviruses and the presence of coliform organisms. Forty-six percent of samples which complied with mandatory *E. coli*/coliform standards did not comply with the enterovirus standard. (See also W91-01211) (Author's abstract)  
W91-01236

#### MICROBIOLOGICAL QUALITY OF AN INLAND SURFACE WATER USED FOR RECREATIONAL PURPOSES.

Severn-Trent Labs., Coventry (England).  
R. Morris.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 353-356, 2 tab, 11 ref.

Descriptors: \*Coliforms, \*Surface water, \*Swimming, \*Viruses, \*Water pollution effects, \*Water quality, \*Water quality standards, Bacteria, Microbiological studies, Monitoring, Pollutant identification, Public health, Recreation, Rivers, Water quality control.

During 1987 an inland surface water was monitored to determine its microbiological quality. The water is extensively used for recreational purposes with users frequently experiencing total immersion. The findings are evaluated against the European Community directive for bathing water quality, the only standard against which the health risk associated with a recreational water can be assessed at the present time. The water failed to meet the mandatory standard set for total coliforms (<10,000 per 100 ml) on all but one occasion of 23 samplings. Similarly, the standard of <2,000 fecal coliforms/100 ml was satisfied on three occasions while the guideline value of <100 fecal streptococci/100 ml was met by eight samples. Virologically, the water failed to meet the standard of nil detectable viruses in a 10 liters sample on 20 of 24 occasions. The users of the water regularly complain of gastroenteritis and it is obvious from the microbiological data that it is inadvisable to use the surface water for recreational purposes. This is particularly important where total immersion can be a feature of the recreational activity. (See also W91-01211) (Author's abstract)  
W91-01237

#### FATE OF GENETICALLY ENGINEERED MICROORGANISMS IN FRESHWATER.

Freshwater Biological Association, Ambleside (England).  
R. W. Pickup, J. R. Saunders, J. A. W. Morgan, C. Winstanley, and J. G. Jones.  
IN: Watershed 89: The Future for Water Quality

in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 375-380, 3 fig, 1 tab, 12 ref.

Descriptors: \*Enterobacter, \*Fate of pollutants, \*Genetic engineering, \*Genetic pollution, \*Pseudomonas, Amino acids, Bioindicators, DNA, *Escherichia coli*, Serratia, Water pollution effects.

The survival of several members of the genera *Pseudomonas* and *Enterobacteriaceae* was monitored in sterile freshwater microcosms. The test organisms were able to survive and maintain a concentration of 1,000-100,000 cells/ml over periods exceeding 60 days. However, their ability to retain the plasmid associated phenotype (xylE) showed both intergeneric and intrageneric differences. Only the auxotrophic test organisms in the absence of vital amino acids declined rapidly once released into the microcosms and became undetectable after 30 days. These results indicate that, while it may be possible to predict the survival of the bacterial host in sterile freshwater, the fate of its recombinant DNA is less predictable. (See also W91-01211) (Author's abstract)  
W91-01240

#### AGRICULTURE: A POSITIVE CONTRIBUTION TO WATER QUALITY.

Imperial Chemical Industries Ltd., Billingham (England).  
For primary bibliographic entry see Field 5G.  
W91-01249

#### EFFECTS AND BEHAVIOUR OF POLLUTANTS DURING ARTIFICIAL GROUNDWATER RECHARGE.

Institut fuer Wasserforschung G.m.b.H., Dortmund (Germany, F.R.).  
N. Zullei-Seibert, and U. Schoettler.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 475-486, 12 fig, 3 tab, 14 ref.

Descriptors: \*Artificial recharge, \*Germany, \*Groundwater pollution, \*Groundwater recharge, \*Path of pollutants, \*Underground waste disposal, \*Water pollution sources, Adsorption, Aromatic compounds, Biodegradation, Disinfectants, Filtration, Heavy metals, Infiltration, Organic carbon, Organic pollutants, Pesticides, Water pollution treatment.

Groundwater as a main source for drinking water supply is affected by industrial, agricultural, and domestic pollution. Risk analyses based on detailed knowledge of the various processes related to infiltration and underground passage are necessary for the protection of drinking water supplies. Experiences during drinking water purification of the waterworks of Dortmund, Germany show that each variation in the concentration of groundwater pollutants is caused by remote complex processes which are dependent on the specific substances involved, the local conditions of the subsoil, and the amount and duration of the pollution. The efficiency of infiltration and underground passage must be estimated with regard to high concentration of pollutants (caused by accidents) as well as to low concentrations over a long time (caused by agriculture or sewage discharge). The infiltrated water with its different components is subject to chemical, physical and biological processes such as filtration, flocculation, adsorption, and degradation. Polychlorinated biphenyls are easily adsorbed to particulate organic matter or accumulated by algae. Heavy metals show a high affinity for appropriate organic or inorganic adsorption structures, and possible remobilization with algal die down in the filter. Reactions within the recharge areas and their effects on the concentrations of pollutants can be described by black-box models. Additional information may be obtained by systematic classification of behavior patterns depending on substance specific properties. The substituted phenols may be easily degraded due to their

molecular structure. (See also W91-01211) (Geiger-PTT)  
W91-01251

#### HYDROLYSIS OF CHLOROSTILBENE OXIDE. II. MODELING OF HYDROLYSIS IN AQUIFER SAMPLES AND IN SEDIMENT-WATER SYSTEMS.

Environmental Protection Agency, Athens, GA. Southeast Environmental Research Lab.  
M. E. S. Metwally, and N. L. Wolfe.  
Environmental Toxicology and Chemistry  
ETOCCK, Vol. 9, No. 8, p 963-973, August 1990.  
5 fig, 5 tab, 22 ref.

Descriptors: \*Biodegradation, \*Chlorostilbene oxide, \*Fate of pollutants, \*Groundwater pollution, \*Hydrolysis, \*Model studies, \*Polycyclic aromatic hydrocarbons, \*Toxicology, \*Aquifers, Hydrogen ion concentration, Kinetics, Sediment chemistry, Sorption.

Epoxides are a class of compounds that are formed as intermediates in the biological transformation of polycyclic aromatic compounds. The disappearance kinetics of 4-chlorostilbene oxide (CSO) were determined in aquifer samples and in sediment-water systems to derive kinetic expressions that describe heterogeneous effects. Disappearance rate constants were determined in heterolytic systems and compared with those obtained in distilled water to delineate the effect of solids on the kinetics of hydrolysis. In both neutral and acid hydrolysis studies, the sorption-desorption rates of CSO were faster than the hydrolysis rates in either the aqueous or sediment-sorbed phases. Both dissolved and sorbed CSO hydrolyzed at either neutral or acidic pHs. Above pH 5, where neutral hydrolysis dominates, the hydrolysis rate constant of CSO in sterile sediment-water systems was the same as in distilled water. This suggests that sorption neither retards nor promotes the natural hydrolysis pathway. At pHs below 5, where acid hydrolysis dominated, the pseudo-first-order hydrolysis rate constant was lower for the sorbed fraction than the rate constant in distilled water at the same pH. This indicates that the hydrolysis rate constant in the sorbed phase is slower than that in the bulk aqueous phase. Kinetics of hydrolysis were studied in raw sediment samples and samples sterilized by heat or with formalin to distinguish between abiotic and biotic hydrolysis processes. Above pH 5, the hydrolysis rate constants were larger in nonsterile systems when compared with the rate constants in the sterile systems, suggesting that both biotic and abiotic pathways contribute to the disappearance of CSO. Below pH 5, the hydrolysis rate constants were, within experimental error, the same in the sterile and nonsterile systems. In aquifer samples, the average disappearance rate constant of CSO was  $0.000085 \pm 0.000011/\text{min}$ , which is about the same as the rate constant in distilled water. These results suggest that there is no heterolytic enhancement of the neutral hydrolysis rate constant by the aquifer materials. (Author's abstract)  
W91-01256

#### EFFECT OF BODY SIZE ON THE UPTAKE AND BIOCONCENTRATION OF DI-2-ETHYLHEXYL PHTHALATE IN RAINBOW TROUT.

Washington State Univ., Pullman. Coll. of Pharmacy.  
B. D. Tarr, M. G. Barron, and W. L. Hayton.  
Environmental Toxicology and Chemistry  
ETOCCK, Vol. 9, No. 8, p 989-995, August 1990.  
6 fig, 1 tab, 29 ref. NIH Grant ES 01995 and EPA Grant R812818.

Descriptors: \*Animal metabolism, \*Bioaccumulation, \*Biological magnification, \*Fish, \*Fish physiology, \*Path of pollutants, \*Phthalates, \*Toxicology, \*Trout, Bioassay, Growth stages, Kinetics, Model studies.

Di-2-ethylhexyl phthalate (DEHP) is widely used as a plasticizer in the production of polyvinyl chloride. Three groups of rainbow trout (*Salmo gairdneri*) having average body weights of 2.9, 61 and 440 g were exposed at 12°C by the water to di-2-ethylhexyl phthalate. The kinetics of uptake and bioconcentration were characterized in each group

using a compartmental model. Most of the model parameters, when expressed per unit body weight, were similar in the three sizes of fish. The two major exceptions were the uptake rate parameter, a measure of the capacity of the gill to extract DEHP from water and the apparent size (volume of distribution) of the large DEHP storage compartment, which is a measure of the capacity of the fish to accumulate DEHP. The values of these parameters declined as body weight increased; they followed the allometric equation with body weight exponents of 0.44 and 0.77, respectively. The body weight-associated changes in the pharmacokinetic parameters caused the bioconcentration factor to decline as body weight increased from 51.5 to 1.6. (Author's abstract)  
W91-01257

#### EQUILIBRIUM PARTITIONING AND BIOACCUMULATION OF SEDIMENT-ASSOCIATED CONTAMINANTS BY INFAUNAL ORGANISMS.

Environmental Protection Agency, Narragansett, RI. Environmental Research Lab.  
J. L. Lake, N. I. Rubinstein, H. Lee, C. A. Lake, and J. Heltshe.  
Environmental Toxicology and Chemistry  
ETOCCK, Vol. 9, No. 8, p 1095-1106, August 1990. 2 fig, 9 tab, 24 ref.

Descriptors: \*Aroclors, \*Bioaccumulation, \*Mollusks, \*Path of pollutants, \*Polychaetes, \*Sediment contamination, \*Toxicology, \*Equilibrium, Mathematical models, Model studies, Organic carbon, Polychlorinated biphenyls, Population exposure, Sediment analysis, Tissue analysis.

The utility and limits of applicability of a simple equilibrium partitioning model for predicting the maximum concentration of neutral organic compounds which can be accumulated by infaunal organisms exposed to a contaminated sediment were examined. Accumulation factors (AFs) for PCBs, the lipid normalized PCB concentration in organisms divided by the organic carbon normalized PCB concentration in sediments, were measured for PCBs in infaunal mollusks and polychaetes at field sites with a range of sediment Aroclor (A-1254) and total organic carbon (TOC) concentrations. The average AFs for A-1254 were found to be higher (average = 4.94; range 3.76 to 7.27) at sites with lower contaminant concentrations (15.0 to 48.3 ng A-1254/g dry sediment) than at more contaminated sites (328-9200 ng/g), where AFs were lower (average = 2.62; range 1.14 to 5.04). AF data grouped on the basis of sediment A-1254 and TOC concentration differed statistically between, but not within each group. Significant differences in mean AFs were found between some species and were lower than that found for bioaccumulation factors on a wet weight basis, indicating the utility of lipid and organic carbon normalization. (Author's abstract)  
W91-01267

#### POLLUTION ASPECTS OF STORM-SEWAGE OVERFLOWS.

Sheffield City Polytechnic (England).

D. J. Balmforth.

Journal of the Institution of Water and Environmental Management JIWMEEZ, Vol. 4, No. 3, p 219-226, June 1990. 8 fig, 1 tab, 12 ref.

Descriptors: \*Combined sewer overflows, \*Sewer systems, \*Storm wastewater, \*Storm-overflow sewers, \*Urban hydrology, \*Wastewater pollution, \*Water pollution sources, Field tests, Model testing, Overflow, Path of pollutants, Pollutants, Stilling basins, Storm runoff, Storm sewers, Stream pollution, United Kingdom.

Storm-sewage overflows are one of the principal sources of urban river pollution in the United Kingdom. Various possible pollutants, such as carbon compounds, faecal matter, toxic pollutants, nutrients, bacterial pollutants such as *E. coli* bacteria, and their effect on the receiving stream are outlined. Features of individual overflow structures which are likely to lead to unsatisfactory performance are also detailed. These include any overflow that has dry-weather evidence of pollu-

tion; causes reduction in river classification; discharges to a watercourse which is used for amenity purposes; provides insufficient relief to the sewerage system downstream; suffers from siltation and/or blockage; is structurally unsound; or has difficult or unsafe access. Since the rationalization and rehabilitation of storm-sewage overflows should only be considered as part of a more general drainage area study, a strategy for rationalization is presented which identifies objectives for effective design and operation. It discusses, in particular, how chambers may be proportioned to give effective separation of visible pollutants. By combining field data with the results of model tests, a comparison of the performance of the main recommended types of overflow structure was made. Maintenance and safety measures include: proper venting; correct throttle design; prevention of solids accumulation on the floor; and safe adequate access points. (Author's abstract)  
W91-01268

#### CHLORINATED SOLVENTS IN UK AQUIFERS.

Waterloo Univ. (Ontario). Inst. for Ground Water Research.

M. O. Rivett, D. N. Lerner, and J. W. Lloyd.  
Journal of the Institution of Water and Environmental Management JIWMEEZ, Vol. 4, No. 3, p 242-250, June 1990. 5 fig, 4 tab, 45 ref.

Descriptors: \*Chlorinated hydrocarbons, \*England, \*Groundwater pollution, \*Path of pollutants, \*Solvents, \*Water pollution sources, Aquifer characteristics, Groundwater data, Monitoring, Water quality.

Background data on chlorinated solvents and all published data on chlorinated solvents in United Kingdom groundwater was reviewed. New data from an aquifer-wide survey of the organic water quality of the Birmingham aquifer (carried out by the University of Birmingham and the Water Research Centre (WRC)) show that contamination by chlorinated solvents is extensive and is greater than that observed in previously published United Kingdom studies. Trichloroethylene contamination is particularly apparent in the Birmingham aquifer, with 40% of the boreholes sampled containing waters above the new UK limit for this contaminant. Fortunately the Birmingham aquifer is not used for public supply. Land use and hydrogeological factors are shown to influence the contamination observed in particular boreholes. The difficulties associated with locating contaminated zones in aquifers, due to the immiscible flow of chlorinated solvents make it difficult to locate the actual source and hence to remove it. Development in the understanding of how solvents move in the subsurface, better field methods to observe aquifer contamination, and computer models to predict with greater accuracy the movement of solvents are all required to observe and remediate aquifer contamination by chlorinated solvents. (Author's abstract)  
W91-01271

#### APPRAISAL OF THE POTENTIAL HEALTH IMPACTS OF SEWAGE DISPOSAL TO UK COASTAL WATERS.

Saint David's Univ. Coll., Lampeter (Wales). Centre for Research into Environment and Health.  
F. Jones, D. Kay, R. Stanwell-Smith, and M. Wyer.

Journal of the Institution of Water and Environmental Management JIWMEEZ, Vol. 4, No. 3, p 295-303, June 1990. 1 tab, 69 ref.

Descriptors: \*Coastal waters, \*Hazard assessment, \*Marine pollution, \*Population exposure, \*Public health, \*Risk assessment, \*United Kingdom, \*Wastewater pollution, \*Water pollution sources, \*Water quality standards, Disinfection, Epidemiology, Wastewater disposal.

The discharge of sewage to the unique United Kingdom (UK) coastal environment has been a traditional and cost-effective means of treatment for many decades. This disposal option is increasingly questioned by professionals with public-health responsibilities as well as by environmental

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

pressure groups. There are limited firm data on the epidemiological significance of existing disposal practices: the established prospective methods, developed by north American workers in this area, have not provided a scientifically-robust, epidemiological, research protocol. This leaves a scientific vacuum for those with operational and policy responsibilities in this important and sensitive area of water resource management. Primary treatment of effluents is essential at all discharges to coastal waters. However, this will not guarantee compliance with European Community (EC) Directive standards and does not ensure the absence of epidemiological risk. Complementary treatment options, such as ultraviolet and ozone disinfection should be evaluated. (Author's abstract)  
W91-01278

**INTERACTION OF CARBON TETRACHLORIDE WITH BETA-NAPHTHOFLOAVONE-MEDIATED CYTOCHROME P450 INDUCTION IN WINTER FLOUNDER (PSEUDOPLEURONectes AMERICANUS).**  
Louisiana State Univ., Baton Rouge. School of Veterinary Medicine.  
For primary bibliographic entry see Field 5C.  
W91-01279

**INDUCTION OF PEROXISOME PROLIFERATION IN RAINBOW TROUT EXPOSED TO CIPROFIBRATE.**  
Massachusetts Univ., Amherst. School of Public Health.  
For primary bibliographic entry see Field 5C.  
W91-01280

**ACID DEPOSITION IN CENTRAL JAPAN.**  
Iowa Univ., Iowa City. Dept. of Chemical and Biochemical Engineering.  
Y. S. Chang, B. S. Ravishanker, G. R. Carmichael, H. Kurita, and H. Ueda.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2035-2049, August 1990. 10 fig, 3 tab, 17 ref. EPRI Contract RP 1630-49.

Descriptors: \*Acid rain, \*Japan, \*Path of pollutants, \*Water pollution sources, Air pollution, Model studies, Nitrates, Nitrites, Simulation analysis, Sulfates.

Previous studies on the long-range transport of pollutants in central Japan have focused on the production and transport of photochemical oxidants. Highly polluted air is found in the central mountainous areas late in the afternoon on clear summer days, resulting from the transport of pollutants from the Tokyo Metropolitan area. The impact of this long-range transport (LRT) on acid deposition at these inland regions is evaluated by simulating a series of hypothetical storms under LRT conditions using the STEM II model. Nitrate and SO<sub>4</sub> concentrations in the rainwater in excess of 100 micromolar are predicted, indicating that the total wet deposition of NO<sub>3</sub> exceeds that of SO<sub>4</sub> by a factor of 2. The wet deposition during evening storms is nearly 100% higher than that during afternoon storms. Simulations with 50% reductions in NO<sub>x</sub> and SO<sub>x</sub> emissions decrease the wet deposition of NO<sub>3</sub> and SO<sub>4</sub> by 40% and 15%. (Author's abstract)  
W91-01283

**TRENDS OF AIR QUALITY AND ATMOSPHERIC DEPOSITION IN TOKYO.**  
Tokyo Metropolitan Research Inst. for Environmental Protection (Japan).  
T. Komeiji, K. Aoki, I. Koyama, and T. Okita.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2099-2103, August 1990. 12 fig, 1 tab, 6 ref.

Descriptors: \*Acid rain, \*Air pollution, \*Japan, \*Path of pollutants, \*Tokyo, \*Water pollution sources, Nitrates, Nitrogen compounds, Sulfates, Sulfur dioxide.

In the late 1960s and early 1970s the levels of SO<sub>2</sub> and SO<sub>4</sub> airborne particulate matter and its elemental compositions were high in Tokyo. However,

in the 1970s their levels rapidly declined because of emission controls and fuel and material switching. Although the usage of heavy oil of high sulfur content temporarily increases SO<sub>2</sub> concentration, the introduction of desulfurization processes for heavy oil reduced the SO<sub>2</sub> concentration drastically. Concurrently, SO<sub>4</sub>(2-) concentrations in rain water also rapidly declined. On the other hand, despite significant emission control of NO<sub>x</sub> from stationary and mobile sources, NO<sub>x</sub> and consequent NO<sub>3</sub>(-) levels in air and precipitation have not reduced. This is due to the increased number of automobiles, particularly of diesel powered trucks. Recently, this decline has slowed down. The number of days in which Mt. Fuji is visible from Tokyo have increased in coincidence with the decrease of particulate matter concentrations. A decrease in the deposition of SO<sub>4</sub> and other species also reflects the decline of air pollution. However, the atmospheric concentration and deposition of oxides of nitrogen have not decreased because of the increase in the number of automobiles. It is also recognized that the alteration of structures in the city changes air quality. (Lantz-PTT)  
W91-01284

**ANALYSIS OF RADM GAS CONCENTRATION PREDICTIONS USING OSCAR AND NEROS MONITORING DATA.**  
State Univ. of New York at Albany. Atmospheric Sciences Research Center.  
P. Middleton, and J. S. Chang.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2113-2125, August 1990. 2 fig, 3 tab, 30 ref. EPA Contract 68D80016.

Descriptors: \*Acid rain, \*Data interpretation, \*Model studies, \*Path of pollutants, \*Regional Acid Deposition Model, Data acquisition, Nitrogen compounds, Northeast Regional Oxidant Study, Oxidation and Scavenging Characteristics, Ozone, Sulfur dioxide.

The ability of the Regional Acid Deposition Model (RADM) to produce realistic atmospheric trace gas concentration patterns for a variety of atmospheric conditions is explored by comparing model results with surface monitoring data. Two frontal storm system episodes, monitored in 1981 as part of the Oxidation and Scavenging Characteristics of April Rains (OSCAR) experiment, and one relatively dry high pressure-system case from the 1979 Northeast Regional Oxidant Study (NEROS) were studied. The temporal and spatial variations of SO<sub>2</sub>, O<sub>3</sub> and N species monitored at selected locations throughout the US and Canada were compared to the corresponding RADM grid-average predictions. Spatial distributions of SO<sub>2</sub> and O<sub>3</sub> daytime (10a-4p) and night-time (10p-4a) RADM concentration averages were compared to the observational averages to confirm that the model and data concentration patterns agreed over the domain. Predictions and observations showed similar patterns of high and low concentrations throughout the region for all three of the events for the daytime comparisons; the lower night-time agreement improved when night-time stability adjustments were applied to the model predictions. Summarizing over all of the individual grid-point, day-total comparisons for all three events, it was found that, for O<sub>3</sub>, all of the pairs were in agreement to better than a factor of two, and 50% of them were in agreement to a factor of 1.1 or better. For SO<sub>2</sub>, 88% of the pairs were in agreement to better than a factor of two and 25% of the pairs were in agreement to a factor of 1.1 or better. Predicted N species concentrations in the 1-4 and 5-7 ppm ranges for two OSCAR cases were comparable to the levels measured at a rural Indiana site during the OSCAR 1 and the OSCAR 4 events. Predictions of NEROS NO in the 3-11 ppb range were comparable with the concentrations measured at a rural Pennsylvania site for a summer 1986 case meteorologically similar to the 1979 NEROS 1 event. In general, higher agreement is associated with well mixed conditions in areas where local characteristics of the observational site more closely resemble the grid-average characteristics. (Lantz-PTT)  
W91-01285

### ACID RAIN MODEL DEVELOPMENT CONSIDERING ALTITUDINAL PRECIPITATION RATE.

Korea Advanced Inst. of Science and Technology, Seoul (Republic of Korea). Dept. of Civil Engineering.  
J. K. Koo, S. O. Ko, and M. S. Hong.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2133-2139, August 1990. 8 fig, 3 tab, 15 ref.

Descriptors: \*Acid rain, \*Mathematical models, \*Model studies, \*Path of pollutants, Aerosols, Air pollution, Cloud physics, Physicochemical properties, Simulation analysis.

A one dimensional Eulerian model is developed to investigate the effect of physico-chemical parameters on the acidification processes of raindrops. The model is structured to treat the complex cloud's microphysical processes in a highly parameterized fashion. For a 1 h rain event simulation, gas depletion ratios range from 35 to 60% for HNO<sub>3</sub>, 40 to 70% for NH<sub>3</sub>, and 25 to 30% for SO<sub>2</sub>. Also, a formula is proposed to predict the rain acidity on the ground using known values of gaseous SO<sub>2</sub> concentration, the height of the rain growth zone, and precipitation rate. The model can be extended to incorporate the cloud microphysical processes in a more sophisticated manner and, in the future, be extended to include aerosol capturing mechanisms. (Lantz-PTT)  
W91-01286

### SEMI-EMPIRICAL APPROACH TO ESTIMATE VERTICAL TRANSPORT BY NONPRECIPITATING CONVECTIVE CLOUDS ON A REGIONAL SCALE.

Research Triangle Inst., Research Triangle Park, NC.  
F. M. Vukovich, and J. K. S. Ching.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2153-2168, August 1990. 13 fig, 1 tab, 29 ref. EPA Contract 68-02-4059.

Descriptors: \*Acid rain, \*Cloud physics, \*Convective clouds, \*Mathematical analysis, \*Path of pollutants, \*Vertical transport, Clouds, Cumulus clouds, Dewpoint, Fluctuations, Sensitivity analysis, Temperature.

A semi-empirical approach was used to estimate the vertical flux of mass of water and pollutants between the boundary layer and the cloud layer in an ensemble of nonprecipitating cumulus clouds. This CUVENT model determines the existence of the cloud ensemble, estimates the cloud amount at cloud base, and establishes the vertical distribution of the convective cloud amount attributed to a cloud population, having a continuous spectrum of cloud depth, using standard meteorological data. The mass flux is then estimated for the ensemble or for a processor cloud, a single cloud which on the average can be used to represent the ensemble using a modified version of the cloud model. Sensitivity analysis of CUVENT examined the behavior of the model as the vertical distribution of temperature and dewpoint changed from one atmospheric state to another. For the initial study, the temperature profile was held constant, and the dew profile varied. In a moist dewpoint profile, there was a small dewpoint depression, on the average, above the top of the boundary layer. In another case, a relatively dry dewpoint profile was used. In all cases, the cloud amount at cloud base was set equal to 1.0. Having cloud amounts < 1.0 will effect the quantitative results more than the qualitative results. In the next analysis, the dewpoint profile was held constant, but the temperature profile above cloud base and in the cloud layer varied. In the first case, the temperature decreased with height through the cloud layer. In the second case, an isothermal layer existed in the cloud layer. In the case where the temperature decreased with height through the cloud layer, the cloud thickness is approximately 1500 m and the maximum vertical velocity is near cloud base and is 53 cm/sec. (Lantz-PTT)  
W91-01287

## Sources Of Pollution—Group 5B

**CHEMISTRY OF DEWS AND FROSTS IN INDIANAPOLIS, INDIANA.**

Butler Univ., Indianapolis, IN. Holcomb Research Inst.

J. R. Foster, R. A. Pribush, and B. H. Carter. Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2229-2236, August 1990. 3 fig, 4 tab, 32 ref. Air Force Office of Scientific Research Grant AFOSR-85-0223.

Descriptors: \*Acid rain, \*Chemical analysis, \*Dew, \*Frost, \*Indianapolis, \*Path of pollutants, Acidification, Air pollution, Calcium, Carbon dioxide, Hydrogen ion concentration, Magnesium, Nitrogen dioxide, Pollutant identification, Potassium, Sodium, Sulfur dioxide.

Dews and frosts forming on chemically Teflon surfaces were sampled for pH and ion concentrations during a 13 month period in urban Indianapolis, Indiana. It was predicted that dews forming in this polluted atmosphere would be acidic due to absorption of SO<sub>2</sub>, NO<sub>2</sub> and CO<sub>2</sub>, but that frost pH would be neutral due to the lack of gas absorption. However, measured pH ranged from 6.0 to 7.2, and dew and frost pH were not significantly different. Anion and cation concentrations did not differ between dews and frosts, implying similar mechanisms and rates for scavenging of atmospheric chemicals. Sulfite and nitrite were present in many samples, indicating SO<sub>2</sub> and NO<sub>2</sub> absorption by both dews and frosts. The presence of ions (K, Ca, Mg, Na) lacking gaseous sources suggested that sedimentation of aerosols, primarily carbonates and salts, from surrounding agricultural lands occurred into dews and frosts as they formed. Carbonate deposition may have been responsible for near-neutral dew and frost pH. Dews sampled from sugar maple leaves were depleted of ammonium and enriched in other ions, but did not differ substantially in pH, compared to dews simultaneously sampled from Teflon. Temporal (overnight) sampling of dews on Teflon showed that dew chemistry changed substantially during the course of the night. (Author's abstract) W91-01288

**HAILSTONES AS CLOUD WATER COMPOSITION PROBES: AN INITIAL ASSESSMENT.**

Washington State Univ., Pullman. Lab. for Atmospheric Research.

For primary bibliographic entry see Field 2K.

W91-01289

**ACID RAIN AND PHOTOCHEMICAL OXIDANTS CONTROL POLICIES IN THE EUROPEAN COMMUNITY: A DECISION ANALYSIS FRAMEWORK.**

Environmental Resources Ltd., London (England).

For primary bibliographic entry see Field 5G. W91-01290

**DEVICE FOR IN SITU DETERMINATION OF GEOCHEMICAL TRANSPORT PARAMETERS. 1. RETARDATION.**

Waterloo Univ. (Ontario). Dept. of Earth Sciences. R. W. Gillham, M. J. L. Robin, and C. J. Ptacek. Ground Water GRWAAP, Vol. 28, No. 5, p 666-672, September/October 1990. 4 fig, 1 tab, 12 ref.

Descriptors: \*Data acquisition, \*Geochemistry, \*Groundwater pollution, \*In situ tests, \*Path of pollutants, \*Tracers, Aquifers, Augers, Measuring instruments, Organic compounds, Strontium.

The retardation factor for dissolved chemicals in groundwater is an important parameter in predicting the rate of migration of contaminants and in the design of remediation schemes for contaminated aquifers. Conventional methods for evaluating retardation factors include laboratory batch and column tests, and in the case of nonpolar organic contaminants, correlations with the organic carbon content of the aquifer material. In these procedures it is difficult to insure the geochemical integrity of the sediment material and the solutions used in the tests, leading to uncertainties concerning the applicability of the results. Alternatively, large-scale tracer tests can be conducted; however, because of

the time and cost requirements, these procedures have generally been limited to research applications. A description is provided of an in situ column procedure for measuring retardation factors. This column is installed in advance of the cutting head of hollow-stem augers, minimizing the geochemical disturbance of the sediment. The sediment within the column is exposed only to natural ground water from the immediate vicinity of the test device. By maintaining geochemical integrity, the method has considerable advantages over laboratory procedures, while being substantially less costly than conventional field tracer tests. Two tests were conducted with the device in which retardation factors for strontium and for five halogenated organic compounds were found to be in good agreement with results obtained by conventional methods. (Author's abstract) W91-01293

**LOGNORMAL DISTRIBUTION OF RADON CONCENTRATION IN GROUND WATER.**

Ecole Polytechnique, Montreal (Quebec). L. Zikovsky, and B. Chah.

Ground Water GRWAAP, Vol. 28, No. 5, p 673-676, September/October 1990. 1 fig, 1 tab, 17 ref.

Descriptors: \*Data interpretation, \*Distribution, \*Groundwater pollution, \*Path of pollutants, \*Radon, Mathematical studies, Statistical analysis, Statistical methods, Uranium.

Data on the concentration of radon in groundwater were compiled from the literature. From this compilation the means, medians, modes, standard deviations, coefficients of skewness and histograms have been calculated. The histograms were compared with the normal and lognormal distribution functions using chi-square test values for goodness of fit. Based on this, the concentrations were found to be lognormally distributed in all cases studied but one. The measured medians and modes were compared with their theoretical counterparts assuming either normality or lognormality; lognormality was found once more. The comparisons of chi-square test values, the differences between the measured medians and means or geometrical means, and the differences between measured modes and means or geometrical modes show that the concentration of radon in groundwater is lognormally distributed. In such cases, reporting only arithmetic means may create a false impression about exposure levels due to radon. A median or mode as a measure of central tendency would be more appropriate. The lognormality appears to be a consequence of heterogeneous distribution of uranium in soils and rocks. (Lantz-PTT) W91-01294

**USE OF TREE-RING CHEMISTRY TO DOCUMENT HISTORICAL GROUND-WATER CONTAMINATION EVENTS.**

Geological Survey, Columbia, SC. Water Resources Div.

D. A. Vroblesky, and T. M. Yanosky. Ground Water GRWAAP, Vol. 28, No. 5, p 677-684, September/October 1990. 9 fig, 27 ref.

Descriptors: \*Chemical analysis, \*Data acquisition, \*Dendrochronology, \*Groundwater pollution, \*History, \*Path of pollutants, \*Tree rings, Chlorides, Chlorine, Groundwater movement, Iron, Landfills, Yellow poplar.

The annual growth rings of tulip trees (*Liriodendron tulipifera* L.) appear to preserve a chemical record of groundwater contamination at a landfill in Maryland. Zones of elevated iron and chlorine concentrations in growth rings from trees immediately downgradient from the landfill are closely correlated temporally with activities in the landfill expected to generate iron and chloride contamination in groundwater. Successively later iron peaks in trees increasingly distant from the landfill along the general direction of groundwater flow imply movement of iron contaminated groundwater away from the landfill. The historical velocity of iron movement (2 to 9 m/yr) and chloride movement (at least 40 m/yr) in groundwater at the site was estimated from element concentration trends of trees at successive distances from the landfill.

The tree ring derived chloride transport velocity approximates the known groundwater velocity (30-80 m/yr). A minimum horizontal hydraulic conductivity (0.01 to 0.02 cm/s) calculated from chloride velocity agrees well with values derived from aquifer tests (about 0.07 cm/s) and from groundwater modeling results (0.009 to 0.04 cm/s). (Author's abstract) W91-01295

**INFILTRATION OF IMMISCIBLE CONTAMINANTS IN THE UNSATURATED ZONE.**

Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.

D. D. Reible, T. H. Illangasekare, D. V. Doshi, and M. E. Malhotra.

Ground Water GRWAAP, Vol. 28, No. 5, p 685-692, September/October 1990. 6 fig, 1 tab, 15 ref.

Descriptors: \*Aeration zone, \*Immiscibility, \*Infiltration, \*Model studies, \*Path of pollutants, \*Soil water, \*Unsaturated zone, Groundwater pollution, Permeability, Vadose zone.

The presence of a nonaqueous liquid phase in the subsurface often controls the rate and magnitude of groundwater contamination. In addition, remediation efforts that do not directly address the nonaqueous phase material are unlikely to provide cost-effective or timely solutions to groundwater contamination risk. Practical modeling tools that describe the fate and transport of a separate contaminant phase are described. Simple sharp front models that parameterize the capillary pressure and relative permeability relationships into effective coefficients can describe the main features of the unsaturated zone infiltration behavior of nonaqueous phase liquids. Experiments have indicated that infiltration of an immiscible organic phase into an initially residually water saturated vadose zone can be predicted using only the spill volume and area, the intrinsic permeability of the medium, the residual and irreducible residual of the infiltrating liquid in the medium, and the capillary rise height of the infiltrating liquid in the medium. The ultimate depth of infiltration can be estimated from only the initial volume and area of the spill and the residual chemical saturation in the soil. This simple modeling approach should be applicable to vadose zone infiltration of any nonaqueous phase that does not disrupt the properties of the soil medium. Volatile chemical infiltration also can be described, but the model is only applicable until vaporization results in a significant loss of mass. In practice, the approach is limited to essentially homogeneous, sandy soils in that fingering in and around heterogeneities, chemical-media interactions (such as electrical interactions with clays) are not considered, and sharply defined capillary pressure versus saturation behavior is assumed. (Lantz-PTT) W91-01296

**FIELD EVALUATION OF IN-SITU BIODEGRADATION OF CHLORINATED ETHENES: PART 2. RESULTS OF BIOTRANSFORMATION EXPERIMENTS.**

Stanford Univ., CA. Dept. of Civil Engineering. For primary bibliographic entry see Field 5G. W91-01299

**PH AND REDOX BUFFERING MECHANISMS IN A GLACIAL DRIFT AQUIFER CONTAMINATED BY LANDFILL LEACHATE.**

Western Michigan Univ., Kalamazoo. Center for Water Research.

A. E. Kehew, and R. N. Passero.

Ground Water GRWAAP, Vol. 28, No. 5, p 728-737, September/October 1990. 9 fig, 4 tab, 21 ref.

Descriptors: \*Fate of pollutants, \*Geochemistry, \*Glacial aquifers, \*Groundwater pollution, \*Hydrogen ion concentration, \*Landfills, \*Oxidation-reduction potential, \*Path of pollutants, \*Water pollution sources, Anions, Bicarbonates, Calcium, Chemical interactions, Chemical precipitation, Chemical reactions, Iron, Magnesium, Siderite, Solubility, Sulfides.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

The KL Landfill in Kalamazoo County, Michigan was closed in June 1979 because of groundwater contamination. Study of water analyses from a monitoring well network has provided insight into a variety of pH and redox buffering reactions within the contaminated plume. The reactions involved in pH and redox buffering are important in controlling the concentrations of many major and minor chemical species in the KL Landfill contaminant plume. Acid leachate causes carbonate material dissolution which, in turn, buffers the pH in the glacial drift aquifer at or near neutral background levels. Increases in calcium, magnesium, and bicarbonate concentrations result from these buffering reactions, thereby increasing the saturation indices of carbonate minerals in groundwater. Supersaturation of carbonate minerals persists possibly because precipitation is retarded kinetically and/or inhibited by complexation of cations with organic ligands in solution or blockage of nucleation sites on mineral surfaces. Determination of saturation indices based on uncorrected titration alkalinity may overestimate carbonate mineral saturation levels because the resulting bicarbonate concentrations erroneously include organic acid anions. Redox reactions in the contaminant plume include oxidation of dissolved organic compounds coupled with reduction of oxidized compounds in dissolved or solid phases. Specific reactions include the reduction of iron and manganese contained in oxyhydroxide solid phases. Dissolved iron concentrations as high as 50 mg/L are attributed to this reaction. Siderite precipitation provides a possible solubility control for iron concentrations in the plume when the saturation index reaches a value of approximately 2.0. It is also possible that dissolved iron persists above saturation levels with respect to carbonate and sulfide phases because of complexation with organic acid ligands. Sulfide mineral precipitation may maintain sulfide concentrations in the plume at very low levels. (Lantz-PTT)  
W91-01300

#### TRIAZINE AND CHLOROACETAMIDE HERBICIDES IN SYDENHAM RIVER WATER AND MUNICIPAL DRINKING WATER, DRESDEN, ONTARIO, CANADA, 1981-1987.

Ontario Ministry of Agriculture and Food, Guelph. Agricultural Lab. Services Branch.  
R. Frank, B. S. Clegg, C. Sherman, and N. D. Chapman.

Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 319-324, May/June 1990. 1 fig, 4 tab, 14 ref.

Descriptors: \*Atrazine, \*Canada, \*Drinking water, \*Herbicides, \*Triazines, \*Water pollution sources, \*Water treatment, Alachlor, Charcoal, Chlorination, Cyanazine, Metolachlor, Metribuzin, Ontario, Pollutant identification, Water pollution.

Herbicide residues were measured in the Sydenham River to determine if these residues were still present in subsequent drinking-water supplies following chlorination. Samples of raw river water from the Sydenham River, Ontario were collected 30 to 50 times per year between 1981 and 1987 along with paired samples of drinking water from the town of Dresden, Ontario, Canada. Atrazine and its metabolite, diethyl atrazine, were found in 89 to 100% of the raw water over the seven year period. Alachlor was found only in 1982, 1984 and 1985 when 2 to 17% of raw waters were contaminated. Cancellation of the registration to use alachlor at the end of 1985 resulted in no residues being found in 1986 and 1987. Cyanazine was found in 3 to 29% (1982-87), metolachlor in 19-27% (1984-87) and metribuzin in 2-7% (1982-86) of raw river water. Comparison of those residues in raw water with those in drinking water revealed that chlorination of river water had no effect in reducing herbicide concentrations. During 1985 the addition of up to 50 mg/L of powdered charcoal to raw water reduced residues to near or below detection limits for atrazine and chloroacetamide herbicides. However, in 1986, with a reduced rate of 20 mg/L of charcoal herbicide residues were only slightly reduced and in 1987 with only 5 mg/L no reductions occurred. (Author's abstract)  
W91-01306

#### PHOTOCHEMISTRY OF HALOGENATED BENZENE DERIVATIVES. XI. EFFECTS OF SODIUM CHLORIDE ON THE AQUATIC PHOTODEGRADATION OF BROMOXYNIL (3,5-DIBROMO-4-HYDROXYBENZONITRILE) HERBICIDE.

Manitoba Univ., Winnipeg. Dept. of Soil Science. J. Kochany, G. G. Choudhry, and G. R. B. Webster.

Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 325-331, May/June 1990. 5 fig, 1 tab, 21 ref.

Descriptors: \*Benzenes, \*Fate of pollutants, \*Halogenated pesticides, \*Herbicides, \*Path of pollutants, \*Photodegradation, \*Photolysis, \*Sodium chloride, Bromoxynil, Photochemistry, Water chemistry, Water pollution.

Aqueous solution phase photochemistry of the herbicide bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) in the presence of various concentrations of sodium chloride was extensively investigated with ultraviolet radiation near 313 nm. In the presence of 0.0005 to 0.025 moles NaCl, the quantum yields for the phototransformation of the herbicide bromoxynil amounted to 0.045  $\pm$  0.005 to 0.017  $\pm$  0.007 vs. 0.052  $\pm$  0.004 in the absence of sodium chloride. These quantum yield data for the photolysis of the herbicide bromoxynil followed the Stern-Volmer equation. The photolysis of the 0.000078 molar aqueous solution of the herbicide bromoxynil in the presence of sodium chloride gave rise to the formation of 3-bromo-4-hydroxybenzonitril, 3-bromo-5-chloro-4-hydroxybenzonitril, 3-chloro-4-hydroxybenzonitril, and 4-hydroxybenzonitril. The products 3-bromo-5-chloro-4-hydroxybenzonitril and 3-chloro-4-hydroxybenzonitril were formed via the photoincorporation of chloride ions into bromoxynil and into the primary photoproduct 3-bromo-4-hydroxybenzonitril. In the case of this photoreaction, the percentages of maximum concentrations of the following photoproducts were obtained after exposures to UV light: 3-bromo-5-chloro-4-hydroxybenzonitril at 10.5 minutes; 3-bromo-4-hydroxybenzonitril at 20.0 minutes; 3-chloro-4-hydroxybenzonitril at 30.0 minutes; and 4-hydroxybenzonitril at 44.0 minutes. 90% disappearance of the starting material was with 44-minute photolysis. The formation of 4-hydroxybenzonitril decreased with the rise in concentration of NaCl. When a mixture of aqueous solutions of 3.0 ml bromoxynil plus 0.5 ml NaCl was exposed to UV light for up to 3 hours, the photoproduct 4-hydroxybenzonitril could not be observed; however, other products, namely, phenols 3-bromo-4-hydroxybenzonitril, 3-bromo-5-chloro-4-hydroxybenzonitril, and 3-chloro-4-hydroxybenzonitril were produced. (Mertz-PTT)  
W91-01307

#### EFFECTS OF SALINITY, TEMPERATURE, AND CADMIUM ON CADMIUM-BINDING PROTEIN IN THE GRASS SHRIMP, PALAEMONETES PUGIO.

Texas Univ. Health Science Center at Houston. School of Public Health. C. L. Howard, and C. S. Hacker.

Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 341-347, May/June 1990. 4 fig, 2 tab, 31 ref.

Descriptors: \*Bioaccumulation, \*Bioassay, \*Bioindicators, \*Cadmium, \*Crustaceans, \*Heavy metals, \*Path of pollutants, \*Salinity, \*Shrimp, \*Temperature effects, \*Toxicology, Grass shrimp, Synergistic effects, Toxicity, Water pollution, Water temperature.

The combined effects of salinity, temperature, and cadmium on the accumulation of cadmium-binding protein were studied in the grass shrimp, *Palaemonetes pugio*. In 96-hour bioassays, shrimp were exposed either to zero or to one of three concentrations of cadmium (0.50, 1.00, and 1.60 mg/L), under three different salinities (15, 25, and 35 parts per thousand) at two different temperatures (20 and 30 °C). Cadmium-binding protein concentrations were quantified in survivors from the 24 exposure groups. Salinity and temperature did not affect survivorship unless the shrimp were also exposed to cadmium. *P. pugio* produced a 10,000-

dalton metallothionein-like cadmium-binding protein when exposed to at least 0.1 mg Cd(2+)/L for 96 hours. Accumulation of cadmium-binding protein was elevated when either the level of cadmium or temperature was increased or salinity was decreased. Grass shrimp surviving the salinity-temperature-cadmium conditions associated with highest mortality exhibited the highest levels of cadmium-binding protein. Thus, cadmium-binding protein accumulation is not only related to cadmium exposure, but can be synergistically affected by environmental factors as well. When the biota are stressed to the point of synthesizing measurable levels of metal-binding proteins a toxic or potentially toxic condition exists. Therefore, cadmium-binding protein accumulation can be used to assess the effects of cadmium stress on a biological level. (Mertz-PTT)  
W91-01309

#### INFLUENCE OF CADMIUM AND ZINC ON CADMIUM TURNOVER IN THE ZEBRAFISH, BRACHYDANIO RERIO.

Uppsala Univ. (Sweden). Dept. of Zoology. For primary bibliographic entry see Field 5C.  
W91-01310

#### SELENIUM ACCUMULATION AND ELIMINATION IN MALLARDS.

Patuxent Wildlife Research Center, Laurel, MD. G. H. Heinz, G. W. Pendleton, A. J. Krynskiy, and L. G. Gold.

Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 374-379, May/June 1990. 3 fig, 2 tab, 18 ref. San Joaquin Valley Drainage Program Intra-agency Agreement No. 6-AA-20-04170.

Descriptors: \*Bioaccumulation, \*Ducks, \*Selenium, \*Toxicology, \*Water pollution effects, Chronic toxicity, Mallards, Mortality, Tissues, Toxicity, Water pollution.

Selenium accumulation and loss were measured in adult mallards (*Anas platyrhynchos*) fed selenomethionine during two experiments. In Experiment 1, both sexes were fed a diet containing 10 parts per million selenium for 6 weeks, followed by 6 weeks on untreated feed. Concentrations of selenium were predicted to reach 95% of equilibrium faster in liver (7.8 days) than in muscle (81 days). The loss of selenium from liver and muscle of females showed half-times of 18.7 for liver and 30.1 days for muscle. Males reached similar levels of selenium in liver and breast muscle as females and declined to similar levels once selenium treatment ended. In Experiment 2, females were fed increasing levels of selenium until some died. Survivors were switched to an untreated diet and selenium was measured in blood, liver, and breast muscle over 64 days. Half-times for loss of selenium from blood was 9.8 days and muscle was 23.9 days. Selenium initially decreased in liver by one-half in 3.3 days, with subsequent half times of 3.9, 6.0, and 45.1 days. (Mertz-PTT)  
W91-01314

#### PREDICTING BIOACCUMULATION POTENTIAL: A TEST OF A FUGACITY-BASED MODEL.

Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.

S. P. Ferraro, H. Lee, R. J. Ozretich, and D. T. Specht.

Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 386-394, May/June 1990. 2 fig, 7 tab, 44 ref.

Descriptors: \*Bioaccumulation, \*Clams, \*Fate of pollutants, \*Fugacity, \*Model studies, \*Oregon, \*Organic pollutants, \*Path of pollutants, \*Water pollution, Accumulation factor model, Mollusks.

Clams (*Macoma nasuta*) from an unpolluted site in Yaquina Bay, Oregon were exposed in the laboratory for 28 days to 6 field-contaminated sediments which varied widely in concentration of 10 organic pollutants. Mean accumulation factors (accumu-

## Sources Of Pollution—Group 5B

lation factors = concentration in tissue/lipid, %/100 divided by concentration in sediment per total organic carbon, %/100 of 8 neutral organic compounds (DDE(p,p'), 2,2',3,3'-tetrachlorobiphenyl, 2,3',4,4',5-penta-chlorobiphenyl, Aroclor 1254, pyrene, chrysene, benzo(a)pyrene, benzo(b,k)fluoranthene) were homogeneous across treatments. Statistically significant differences were detected between some treatment accumulation factors for DDD(p,p') and benz(a)anthracene, and between some chemicals within treatments. Accumulation factors were less than 2 and less variable in highly polluted, organically enriched sediments (total organic carbon  $\geq 3.69 \pm 0.044\%$ ), but sometimes exceeded 2 in clams exposed to surficial (0-2 cm deep) sediments with low pollutant concentration and low organic carbon content ( $\leq 0.86 \pm 0.037\%$ ). These results suggest that the accumulation factor model may provide reasonable estimates of bioaccumulation potential of hydrophobic neutral organic compounds in organically enriched, polluted sediments. (Author's abstract)

W91-01316

#### ACID PRECIPITATION AND FOOD QUALITY: INHIBITION OF GROWTH AND SURVIVAL IN BLACK DUCKS AND MALLARDS BY DIETARY ALUMINUM, CALCIUM, AND PHOSPHORUS.

Patuxent Wildlife Research Center, Laurel, MD. For primary bibliographic entry see Field 5C. W91-01320

#### EFFECT OF PH ON THE ACCUMULATION KINETICS OF PENTACHLOROPHENOL IN GOLDFISH.

Washington State Univ., Pullman. Coll. of Pharmacy. G. R. Stehly, and W. L. Hayton. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 3, p 464-470, May/June 1990, 4 fig, 3 tab, 26 ref. National Institutes of Health, United States Public Health Service grant ES 01995 and U.S. EPA grant R812818.

Descriptors: \*Acid rain effects, \*Bioaccumulation, \*Chlorinated hydrocarbons, \*Fish physiology, \*Hydrogen ion concentration, \*Path of pollutants, \*Pentachlorophenol, \*Toxicity, \*Water pollution effects, Carassius, Goldfish, Kinetics, Metabolism.

The kinetics of accumulation of pentachlorophenol at various pH values were investigated to explore how pH-dependent accumulation might influence pentachlorophenol toxicity. Goldfish (*Carassius auratus*) were exposed to 5 microgram pentachlorophenol/L in a static system buffered with 7.5 micromoles bicine or N,N-bis(2-hydroxyethyl)-2-aminoethane sulfonic acid at pH 7.0, 8.0, or 9.0. The amount of pentachlorophenol in the fish, concentration of pentachlorophenol in water, and the total amount of metabolites in the system were measured after exposure of fish from 1 to 96 hours. Equations for these variables based on a two compartment pharmacokinetic model were fitted simultaneously to the data using the model NONLIN, which uses an iterative nonlinear least squares technique. Uptake clearance, metabolic clearance, and apparent volume of distribution of pentachlorophenol decreased as pH increased. The decrease in pentachlorophenol accumulation with increased pH was not due solely to a pH-induced decrease in uptake. In addition, the distribution of pentachlorophenol within the fish was altered by changes in the external pH. The pH-associated changes in distribution may have altered access of pentachlorophenol to sites of metabolism, thereby altering the metabolic clearance. The pH-related changes in the pharmacokinetics of pentachlorophenol resulted in a decrease in its bioconcentration factor with an increase in pH and account both for the decreased capacity of the fish to accumulate pentachlorophenol and for its reduced LC50. (Author's abstract)

W91-01321

#### POLYCHLORINATED BIPHENYLS IN HOUSTONIC RIVER SEDIMENTS IN MASSACHUSETTS AND CONNECTICUT, USA: DE-

#### TERMINATION, DISTRIBUTION, AND TRANSPORT.

Connecticut Agricultural Experiment Station, New Haven. C. R. Frink, B. L. Sawhney, K. P. Kupl, and C. G. Fredette. Environmental Auditor ENVAE8, Vol. 1, No. 2, p 79-130, 1990, 12 fig, 36 tab, 33 ref, 3 append.

Descriptors: \*Massachusetts, \*Path of pollutants, \*Polychlorinated biphenyls, \*River sediments, \*Sediment contamination, Connecticut, Lake sediments, Lakes, Pollution load, Rivers, Water pollution.

Polychlorinated biphenyls (PCBs) have accumulated in the Housatonic River wherever sediments have accumulated. The concentration of PCBs in these sediments increased gradually with increasing distance upstream and then increased sharply in Woods Pond, the first impoundment below Pittsfield, Massachusetts. The distribution of PCBs within impoundments was found to be controlled by the distribution of fine-grained sediment. Calculations of the mass of PCBs in the river sediment indicate that, of the estimated total of 22,200 pounds, about 60% is in Massachusetts and nearly all of this amount is in sediment in Woods Pond. The remaining 40% of the total is in sediment in Connecticut: about 29% is in Lake Lillinnah, 10% is in Lake Zoar, and small amounts are at other locations. An analysis of these estimates indicates that errors should be within  $\pm 50\%$ . Transport of PCBs by suspended sediment down the river into Connecticut is estimated to be at the rate of 250 to 500 pounds per year. The results suggest that removal or containment of sediment in Woods Pond would help to alleviate further transport of PCBs into Connecticut. (Author's abstract)

W91-01328

#### EPILIMNETIC CARBON FLUX AND TURNOVER OF DIFFERENT PARTICLE SIZE CLASSES IN OLIGO-MESOTROPHIC LAKE LUCERNE, SWITZERLAND.

Eidgenössische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewässerschutz, Dübendorf (Switzerland). Inst. of Aquatic Sciences. J. Bloesch, and U. Uehlinger. Archiv fuer Hydrobiologie AHYBA4, Vol. 118, No. 4, p 403-419, June 1990, 6 fig, 4 tab, 44 ref.

Descriptors: \*Carbon cycle, \*Epilimnion, \*Eutrophication, \*Lake Lucerne, \*Limnology, \*Mesotrophic lakes, \*Oligotrophic lakes, \*Particulate matter, \*Switzerland, \*Water pollution effects, Excretion, Food habits, Lake turnover, Organic carbon, Particle size, Primary production, Respiration, Seasonal variation.

The carbon turnover in five different particle size classes ( $\geq 200$  microm, 30-200 microm, 12-30 microm, 3-12 microm,  $\leq 3$  microm) was investigated in Lake Lucerne during 1984-1985. The smaller size fractions ( $\leq 12$  microm) were dominant in sestonic particulate organic carbon (POC) and primary production during summer stratification, whereas larger particles ( $\geq 30$  microm) were abundant during winter turnover. Settling POC consisted mainly of large particles throughout the season. This pattern demonstrates the existence of biological particle transformation through zooplankton grazing (fecal pellet production), possibly supported by other biological and/or physico-chemical processes. Specific net increase rates of POC did not show much seasonal variation while scattering around zero. This is indicative of significant specific loss rates immediately compensating high production rates. POC sedimentation rates amounted to 12-39% of total loss in the larger size classes, and ca 20% of the primary production ( $193 \text{ g C ass/sq m/y}$ ) settled out of the epilimnion. Particulate C loss through wash-out did not significantly affect epilimnetic C turnover. Respiration was the dominant loss rate (68-79% of total loss in the size classes  $\leq 12$  microm). Grazing usually was not of great importance, except for the period in May/June when *Daphnia* grazed on abundant nanoplankton. Excretion was less than 7% of total loss in all size classes and did not contribute much to C turnover. It was concluded that epilimnetic C regeneration

(including respiration, grazing, and excretion) amounted to ca 80% of the primary production, which is in the same range as P regeneration. (Author's abstract)

W91-01335

#### COMPARISON OF HISTORICAL AND RECENT DATA ON HYDROCHEMISTRY AND PHYTOPLANKTON IN THE RIJNLAND AREA (THE NETHERLANDS).

Hoogheemraadschap van Rijnland, Leiden (Netherlands). S. P. Klapwijk.

Hydrobiologia HYDRB8, Vol. 199, No. 2, p 87-100, July 24, 1990, 5 fig, 6 tab, 32 ref.

Descriptors: \*Acid rain effects, \*Canals, \*Eutrophic lakes, \*Eutrophication, \*Phytoplankton, \*The Netherlands, \*Water chemistry, \*Water pollution effects, Algal blooms, Biological oxygen demand, Chlorophyll a, Limiting nutrients, Nitrogen, Orthophosphates, Phosphorus, Transparency.

In two canals and two lakes in the western part of the Netherlands a comparison was made between data on water chemistry and phytoplankton from 1941/1942 and recent data. Orthophosphate, and to some extent inorganic nitrogen have increased greatly, particularly in the Gouwe canal where Rhine water enters the area. The inorganic N/P mass ratio decreased in the last 45 years, indicating that the limiting nutrient has changed from phosphate in 1941 to nitrogen in 1987. The average seston volume, measured by filtering 100 L water through a plankton net (50 microm), has doubled. Blooms of the blue-green alga *Microcystis aeruginosa* occurred both historically and recently. The disappearance or reduction of several plankton species indicates the community has become impoverished in the last decade. There has been no change in the saprobic index. Chlorophyll-a and transparency for 1941 were estimated based on correlations between chlorophyll-a and biological oxygen demand (BOD) and between transparency and seston volume using the 1987 data. The average chlorophyll-a concentration in the lakes has doubled or tripled in the last 45 years and the mean transparency in the Gouwe canal declined from 75 to 50 cm. Submerged higher plants at some sites have disappeared in the last decade. Using these results, ecological objectives for combating eutrophication in canals and lakes and possibly the river Rhine can be developed. (Author's abstract)

W91-01352

#### SEASONAL CHANGES IN THE DISSOLVED FREE AMINO ACID AND DOC CONCENTRATIONS IN A HYPERTROPHIC AFRICAN RESERVOIR AND ITS INFLOWING RIVERS.

Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology. For primary bibliographic entry see Field 2H. W91-01356

#### DISTRIBUTION OF SHORT CHAIN CARBOXYLIC ACIDS IN EUTROPHIC DRAINAGE CHANNELS.

Sussex Univ., Brighton (England). School of Biological Sciences.

P. W. G. Doldorff, and J. D. Thomas. Hydrobiologia HYDRB8, Vol. 199, No. 3, p 243-260, July 31, 1990, 12 fig, 4 tab, 62 ref.

Descriptors: \*Carboxylic acids, \*Dissolved organic matter, \*Drainage canals, \*England, \*Eutrophication, Acetates, Butanoate, Dissolved oxygen, Diurnal variation, Hypolimnion, Propanoate, Seasonal variation, Sediments, Stratification.

Although it is generally accepted that dissolved organic matter (DOM) plays a central role in the metabolism of freshwater systems, little is known about its chemical composition. Therefore, the short chain carboxylic acids which are one component of DOM were investigated. The concentration of the C2-C5 carboxylic acids in the water column and sediment of shallow, eutrophic, drainage channels (Lewes Brooks, UK) were measured by gas chromatography. The concentrations of

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

these acids were negatively correlated with dissolved oxygen. The highest concentrations of acetate (up to 200 microM), propanoate (up to 38 microM) and butanoate (up to 1.2 microM) were measured during the summer in the water above the sediment, which became hypoxic during this period. Both acetate and propanoate concentrations declined at night. High concentrations of the acids were also recorded in reedbeds, which were also hypoxic. Only acetate was detected in the sediment pore water (up to 168 microM). Its concentration declined during the autumn and winter and with increasing depth within the sediment. The short chain carboxylic acid pool which accumulates in the hypolimnion and sediment of the drainage channels constitutes a potential source of energy for bacteria, algae, and invertebrates, particularly during periods of mixing of the water column following prolonged stratification that may occur during autumnal turnover of lakes. (White-Reimer-PTT)  
W91-01359

**IMPLICATIONS OF AQUATIC ANIMAL HEALTH FOR HUMAN HEALTH.**  
Harvard Medical School, Boston, MA. Dept. of Pathology.  
For primary bibliographic entry see Field 5C.  
W91-01375

**RELATIONS BETWEEN ACID RAIN AND VEGETATION-ARBUSCULAR MYCORRHIZA.**  
Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.  
For primary bibliographic entry see Field 5C.  
W91-01410

**DRY DEPOSITION OF SULFUR: A 23-YEAR RECORD FOR THE HUBBARD BROOK FOREST ECOSYSTEM.**  
New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies.  
G. E. Likens, F. H. Bormann, L. O. Hedin, C. T. Driscoll, and J. S. Eaton.  
Tellus TELLAL, Vol. 42B, No. 4, p 319-329, September 1990. 5 fig, 49 ref.

Descriptors: \*Acid rain, \*Chemistry of precipitation, \*Dry deposition, \*New Hampshire, \*Sulfur, Experimental basins, Forest watersheds, Hubbard Brook, Mass-balance method, Precipitation, Regression analysis, Streams, Sulfur dioxide.

Dry deposition of S was estimated for watershed-ecosystems of the Hubbard Brook Experimental Forest, New Hampshire, from 1964-65 through 1986-87. Two approaches, a regression analysis of bulk precipitation inputs and stream outputs and a mass-balance method, gave similar average values for Watershed 6 (430 equivalents SO<sub>4</sub>(2-)/hectare/year for regression analysis and 410 equivalents SO<sub>4</sub>(2-)/hectare/year for the mass-balance over the 23-year period). Dry deposition contributed about 37% of total S deposition, varying from 12% in 1964-65 to 61% in 1983-1984. Long-term data from replicated watershed-ecosystems showed that temporal variability in estimates of dry deposition was considerably greater than spatial (between watersheds) variability. Therefore, when using the mass-balance method for estimating dry deposition, short-term estimates of S dry deposition may be influenced by hydrology and must be interpreted with caution. No long-term, linear trend in dry deposition of SO<sub>4</sub>(2-) was observed during the last 23 years, despite a 40% reduction in wet deposition of SO<sub>4</sub>(2-) and a similar decrease in emissions of SO<sub>2</sub> in the northeastern U.S. These differences in deposition trends may be due to differences in source areas for wet and dry deposition and have policy implications relative to regulation of anthropogenic emissions. (Mertz-PTT)  
W91-01411

**MATHEMATICAL MODEL OF BACTERIAL CONTAMINATION OF THE MORLAIX ESTUARY (FRANCE).**  
IFREMER, Paris (France).  
J. C. Salomon, and M. Pommerehne.  
Water Research WATRAG, Vol. 24, No. 8, p 983-

994, August 1990. 10 fig, 13 ref.

Descriptors: \*Bacteria, \*Escherichia coli, \*Estuaries, \*France, \*Model studies, \*Morlaix Estuary, Salinity, \*Path of pollutants, \*Water pollution, Bacterial transport, Coliforms, Contamination, Mathematical studies, Shellfish, Water quality.

The sanitary problem of the Morlaix estuary (France) motivated the development of a physical/bacteriological mathematical model. The physical part of the model is based on well-known physical laws and, for testing and tuning purposes, only a few salinity measurements were necessary. Using a modeling procedure, knowledge concerning bacterial transport and disappearance can be attained that provides useful management information for minimizing fecal pollution in shellfishing areas such as Morlaix Bay. A set of two numerical models was built to simulate currents, water fluxes, transit times, trajectories, dispersion and bacterial decay. The models were tuned and fed by survival trials carried out in the field with *Escherichia coli* strains. Die-off rates ranged from 2 hours to 1 week. Model results compared well with in situ measurements and showed that, in all circumstances, physical dilution processes are much more efficient than mortality in this estuary. The last simulations provided suggestions for improving water quality in the study area. This modeling exercise is also of interest because the numerical code written for Morlaix estuary may be easily transformed for use in other coastal areas. The model is thus a general management tool useful in high hydrodynamic areas. (Mertz-PTT)  
W91-01419

**SPECIES-RELATED VARIATIONS OF SILVER BIOACCUMULATION AND TOXICITY TO THREE MARINE BIVALVES (VARIATIONS INTER-SPECIFIQUES DE LA BIOACCUMULATION ET DE LA TOXICITE DE L'ARGENT A L'EGARD DE TROIS MOLLUSQUES BIVALVES MARINS).**  
Nantes Univ. (France). Lab. de Ecotoxicologie de Milieux Aquatiques.  
C. Metayer, C. Amiard-Triquet, and J. P. Baud.  
Water Research WATRAG, Vol. 24, No. 8, p 995-1001, August 1990. 2 fig, 6 tab, 24 ref. English summary.

Descriptors: \*Bioaccumulation, \*Mollusks, \*Path of pollutants, \*Silver, \*Toxicity, Crassostrea, Food chains, Heavy metals, Mussels, Mytilus, Oysters, Scallops, Water pollution.

Previous data about silver in marine molluscs have shown a high variability of both accumulation and toxicity of this metal. A potential relationship between these factors was examined. In a preliminary experiment, three species of bivalves (*Crassostrea gigas*, *Mytilus galloprovincialis*, *Chlamys varia*) were exposed to silver concentrations varying from 1 to 1000 microgram Ag/L in order to determine parameters of lethal toxicity. Then, specimens of the same species were exposed to sublethal levels of silver through food, water or both food and water. In this main experiment, the level of silver was identical (20 microgram Ag/L) in the culture medium of algae used as food and in the rearing medium of bivalves. Since the nominal levels of silver in water decreased during the experiment, seawater and contaminant were renewed every day. The species-related variations of mean lethal time revealed that the most resistant species was the oyster and the lesser one was the scallop. The patterns of bioaccumulation in soft tissues were different in oysters—in which the maximal concentration was reached within 2 weeks—and in mussels—in which this maximum was not reached after 4 weeks. Exposure to silver via food induced a significant uptake of this metal in soft tissues of bivalves, but it was low compared to uptake from seawater and to the contamination from the double method of exposure. The species-related behavior of silver may be interpreted from the point of view of ecotoxicological consequences. Species such as the oyster, with a low susceptibility and high ability to concentrate silver, could have an important role as the vector of contamination in food webs. Species such as the scallop, able to concentrate high levels of silver and very susceptible, could be

eliminated from polluted ecosystems, but their role in trophic transfer will be eliminated. Species such as the mussel, which accumulate only low quantities of silver, will not have any role in food chain contamination and their intermediate susceptibility could have consequences only in highly polluted environments. (Mertz-PTT)  
W91-01420

**SEASONAL AND LONG-TERM TRENDS IN TRUCKEE RIVER NUTRIENT CONCENTRATIONS AND TRUCKEE RIVER NUTRIENT CONCENTRATIONS AND LOADINGS TO PYRAMID LAKE, NEVADA: A TERMINAL SALINE LAKE.**  
Fish and Wildlife Service, Columbia, MO.  
D. L. Galat.  
Water Research WATRAG, Vol. 24, No. 8, p 1031-1040, August 1990. 5 fig, 4 tab, 48 ref.

Descriptors: \*Eutrophication, \*Nevada, \*Nitrogen, \*Nutrient transport, \*Path of pollutants, \*Phosphorus, \*Saline lakes, Effluents, Fluctuations, Lakes, Pollution load, Precipitation, Pyramid Lake, Rivers, Truckee River, Water pollution.

Mass-discharge of phosphorus and nitrogen from Truckee River to Pyramid Lake, Nevada, was estimated for 15 years (1973-1987) and related to changes in quantity and quality of sewage effluent discharged into the river. Effluent nitrogen loadings to Truckee River increased by about 6%/year, whereas phosphorus discharge beginning in 1982 was reduced 90% by phosphorus removal. Water discharged annually by Truckee River to Pyramid Lake varied widely among years, ranging from about 42,000,000 to 2,420,000,000 cubic meters. Anomalous regional precipitation patterns associated with strong El Nino-Southern Oscillation events resulted in below-average Truckee River discharge from 1977 to 1979, and above-average discharge from 1982 to 1984 and 1986. Mass-transport of soluble reactive phosphorus to Pyramid Lake declined from 146 to 94 mg/square m/year after phosphorus removal, whereas total phosphorus loadings increased from 217 to 396 mg/square m/year. There were no significant long-term trends in total nitrogen loadings to Pyramid Lake (mean 1640 mg/square m/year; range: 112-5500 mg/square m/year), despite increases in effluent nitrogen loadings to Truckee River. Seasonal and annual fluctuations in fluvial discharge, changes in quantity and quality of effluent discharged to Truckee River and in-river biological uptake and transformations were responsible for the variability in in-stream nutrient concentrations and projected loadings to Pyramid Lake. (Author's abstract)  
W91-01425

**COMMENTS ON THE HYDROCHEMICAL REGULATION OF THE HALOGEN ELEMENTS IN RAINFALL, STEAMFLOW, THROUGHFALL AND STREAM WATERS AT AN ACIDIC FORESTED AREA IN MID-WALES.**  
Institute of Hydrology, Wallingford (England).  
C. Neal, C. J. Smith, J. Walls, P. Billingham, and S. Hill.  
Science of the Total Environment STENDL, Vol. 91, p 1-11, February 1990. 6 fig, 3 tab, 24 ref.

Descriptors: \*Acidic water, \*Chemistry of precipitation, \*Forest watersheds, \*Groundwater chemistry, \*Halogens, \*Path of pollutants, \*Wales, Acid rain, Acid streams, Bromine, Chemical analysis, Coniferous forests, Fluorine, Iodine, Marine climates, Seasonal variation, Steamflow, Stream pollution, Throughfall, Watersheds.

Total fluorine, chloride, bromide and total iodine concentration data from a 5 year study of rainfall, throughfall, stemflow and streamwater at the Hafren conifer plantation are presented. Results show four main features. First, in rainfall a strong maritime influence is observed for chloride and bromide, while enrichment occurs for total fluorine and total iodine relative to chloride, reflecting seawater/atmosphere fractionation processes. Second, variation of chloride, bromide and total

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iodine is much lower in the streamwaters compared with the rainfall input, showing the ability of the catchment to damp rainfall chemistry even though 'flashy' hydrograph response is observed. Total fluorine does not exhibit this damping and the reason for this difference remains unclear. Third, there is a net release of total fluorine from the catchment above that supplied from the rainfall, while net losses for bromide and total iodine occur as water passes from rainfall to the stream. Fourth, marked seasonal oscillations occur for streamwater bromide and total iodine concentrations; it is hypothesized that this relates to organic matter breakdown within the catchment during the summer period when biological activity is at its highest. (Author's abstract)  
W91-01447

**TIME TREND OF PCB CONCENTRATIONS IN SURFACE SEDIMENTS FROM A HYPERTROPHIC, MACROALGAE POPULATED AREA OF THE LAGOON OF VENICE.**  
Venice Univ. (Italy). Dept. of Environmental Science.

B. Pavoni, C. Calvo, A. Sfriso, and A. A. Orio. Science of the Total Environment STENDL, Vol. 91, p 13-21, February 1990. 3 fig, 1 tab, 19 ref.

Descriptors: \*Algae, \*Eutrophication, \*Lagoons, \*Marine sediments, \*Path of pollutants, \*Polychlorinated biphenyls, \*Water pollution sources, Algal blooms, Anoxia, Biomass, Chemical analysis, Fate of pollutants, Italy, Seasonal variation, Venice.

The preliminary results of a study to investigate the role of macroalgae in the variations of polychlorinated biphenyl (PCB) concentrations in the surface sediments of the lagoon of Venice are reported. The concentrations of PCBs were determined over a period of 1 year in surface sediments sampled monthly and semi-monthly in the lagoon. At the sampling station, due to the poor water circulation and an over-abundance of nutrients, macroalgae thrive in spring-summer and standing crops > 12 kg/sq m were seen. As a consequence of rapid algal decomposition, sediment PCB concentrations were observed to increase. In particular, on occasions when anoxia occurred at the end of July and all the biomass had decayed, PCB concentrations increased by more than one order of magnitude. In March, when macroalgae started to grow, concentrations were 13 ng/g (dry wt); in July-August they exceeded 100 ng/g. The sediment PCB concentrations were restored to the previous values after algal biomass became negligible, in November. Concentrations of PCBs in young algae fronds were 27 +/- 12 ng/g and 121 +/- 4 ng/g in older fronds. (Author's abstract)  
W91-01448

**CHEMICAL COMPOSITION AND ACIDITY OF RAINFALL IN THE ALLIGATOR RIVERS REGION, NORTHERN TERRITORY, AUSTRALIA.**

Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia). B. N. Noller, N. A. Currey, G. P. Ayers, and R. W. Gillett.

Science of the Total Environment STENDL, Vol. 91, p 23-48, February 1990. 6 fig, 6 ref, 47 ref.

Descriptors: \*Acid rain, \*Australia, \*Chemistry of precipitation, \*Hydrogen ion concentration, \*Path of pollutants, Acetates, Air pollution sources, Chemical analysis, Chlorides, Conductivity, Nitrates, Organic acids, Phosphates, Pollutant identification, Rainfall, Sulfates.

Rainfall in the Alligator Rivers Region, Northern Territory, is essentially restricted to the period October to April. Rainwater samples from eight sites show that pH is consistently between 4.0 and 5.0, and confirms previous observations of the widespread occurrence of acidic rainwater across the northern parts of Australia. Measurements of anions (sulfate, nitrate, chloride, phosphate) and weak organic acids (formate and acetate) in rainfall, together with pH and conductivity, have shown the presence of local concentrations of ions and presence of free acidity in excess of that attributed to dissolved carbon dioxide. Much of the

acidity was associated with the presence of weak acids; for example, for all Magela samples 47% was weak acids compared with 25.5, 13 and 8% for hydrochloric, sulfuric and nitric acids, respectively. Acidity due to sulfate was therefore low, but sulfate in excess of that derived from sea-salt was of large magnitude; for example, 83% of sulfate for all Magela samples was excess. Possible sources of acidity are natural (burning of vegetation, soil dust, lightning, biogenic emissions from soils and oceans and volcanoes), and anthropogenic (sulfuric acid plant and electricity generating stations and minor emissions from calciners and sulfuric acid aerosols in open vats locally at Jabiru and nearby Nabarlek). The impact of sulfur emissions from the Ranger uranium mine/mill complex (sulfuric acid plant and electricity generating station) on rainwater acidity in the surrounding Jabiru area was examined, but the fate of the sulfur dioxide emissions was not known. Difficulties in establishing the significance of contributions from anthropogenic sources against this background of natural acidity are attributed to a lack of information on the proportions of chloride, sulfate and nitrate from these sources. (Author's abstract)  
W91-01449

**ZINC IN POOR SANDY SOILS AND ASSOCIATED GROUNDWATER. A CASE STUDY.**

Amsterdam Univ. (Netherlands). Landscape and Environmental Research Group.

G. B. M. Pedrol, W. A. C. Maasdam, and J. M. Verstraten. Science of the Total Environment STENDL, Vol. 91, p 59-77, February 1990. 8 fig, 3 tab, 55 ref.

Descriptors: \*Air pollution effects, \*Groundwater pollution, \*Path of pollutants, \*Sandy soils, \*Soil chemistry, \*Water pollution sources, \*Zinc, Cadmium, Chemical analysis, Copper, Forest soils, Groundwater chemistry, Groundwater movement, Heavy metals, Lead, Mineral industry, Pollutant identification, Soil analysis, Soil contamination, Soil types, The Netherlands.

High concentrations of zinc (up to 15 mg/L) were observed in most of the acid recharge groundwater in an area of 30 sq km in use as farmland and as a nature reserve in a coversand landscape at the Dutch-Belgian border. These zinc loads are assumed to be associated with atmospheric deposition from zinc smelters in the region. To explain spatial differences in the zinc content of the groundwater, soil samples were taken from organic and mineral horizons down to the groundwater table of two comparable soil profiles under Scotch pine, which had associated groundwater differing in zinc content by a factor of 40. No appreciable differences could be detected between these two soils. The total and extractable heavy metal contents (Pb, Cu, Cd, Zn) of both soils were comparable with reference situations, only the zinc contents were slightly higher than normal. The complexing capacity of the groundwater corresponding to both soil profiles was small. Longitudinal study of the zinc contents of the heavily loaded groundwater compared with chloride indicates that zinc concentrations increase disproportionately during the growing season. Few references are available on the behavior of zinc and other trace metals in groundwater. Atmospheric input of heavy metals is probably responsible for the locally high zinc concentrations in groundwater, but, to a considerable extent, lateral mobilization and immobilization processes within the phreatic reach regulate these concentrations. (Author's abstract)  
W91-01450

**CHEMISTRY OF CARBONYL COMPOUNDS IN PO VALLEY FOG WATER.**

Consiglio Nazionale delle Ricerche, Bologna (Italy). Ist. FISBAT.

M. C. Facchini, J. Lind, G. Orsi, and S. Fuzzi. Science of the Total Environment STENDL, Vol. 91, p 79-86, February 1990. 1 fig, 2 tab, 22 ref.

Descriptors: \*Acid rain, \*Aldehydes, \*Carbonyl compounds, \*Chemistry of precipitation, \*Fog, \*Fogwater chemistry, \*Path of pollutants, \*Water pollution sources, Air pollution, Atmospheric water, Chemical analysis, Formaldehyde, Italy,

Laboratory methods, Po Valley, Seasonal variation.

Measurements were made of the free and bound carbonyl compounds in Po Valley fog water samples. Free and then total carbonyls were determined after cleaving the possible adducts by NaOH addition. The hydroxymethanesulfonic acid concentration was inferred as the difference between the two measurements, making the assumption that hydroxymethanesulfonic acids are by far the most abundant adducts of carbonyl compounds in the atmospheric liquid samples. High concentrations of formaldehyde (HCHO) were detected in fog water (from 16 to 567 micromolar; average, 130 micromolar). The oxidant-limiting conditions during fog season (fall-winter months) favor the presence of a large fraction of HCHO in the form of adducts with hydroxymethanesulfonate: 85% of the total HCHO on average. Other carbonyl compounds were detected in the fog water: acetaldehyde, acrolein and acetone, but typically in much lower concentrations than formaldehyde. These other carbonyl compounds do not appear to be present in bound form. (Author's abstract)  
W91-01451

**CONSOLIDATION AND CONTAMINANT MIGRATION IN A CAPPED DREDGED MATERIAL DEPOSIT.**

Army Engineer Waterways Experiment Station, Vicksburg, MS.

For primary bibliographic entry see Field 5E.  
W91-01453

**GEOGRAPHICAL DISTRIBUTION OF CONTAMINANTS AND PRODUCTIVITY MEASURES OF HERRING GULLS IN THE GREAT LAKES: LAKE ERIE AND CONNECTING CHANNELS 1978/79.**

Canadian Wildlife Service, Burlington (Ontario). Ontario Region.

D. V. Weseloh, P. Mineau, and J. Struger. Science of the Total Environment STENDL, Vol. 91, p 141-159, February 1990. 3 fig, 9 tab, 36 ref.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Great Lakes, \*Gulls, \*Lake Erie, \*Path of pollutants, \*Productivity, Chemical analysis, Chlorinated hydrocarbons, Correlation analysis, DDE, DDT, Data analysis, Dieldrin, Eggs, Fate of pollutants, Halogenated pesticides, Pesticide drift, Pesticide residues, Polychlorinated biphenyls, Water pollution effects.

The distribution and size of colonies, residue levels of DDE, DDT, hexachlorobenzene (HCB), dieldrin, mirex and polychlorinated biphenyls (PCBs) in eggs, productivity and eggshell thickness were determined for herring gulls at 14 sites in Lake Erie and connecting channels. The center of distribution for breeding herring gulls was the Western Basin where approximately 90% of the 6200 nests in the study area were located. PCB and DDE levels ranged from 35 to 140 ppm (wet weight) and from 2.8 to 9.4 ppm, respectively; all other residues were < 0.49 ppm. Most organochlorine residue levels were highest in eggs from colonies in or near the Niagara or Detroit Rivers. Mirex residues were greatest in the Niagara River and decreased significantly to the west. PCB residues were greatest in the Detroit River and decreased significantly to the east. The lowest levels generally came from colonies in the Sandusky Basin and near Pelee Island in western Lake Erie. Discriminant function analysis of six organochlorine contaminants correctly classified 90% or more of the eggs from up to four colonies in one or more years. PCB and HCB levels appeared to have the greatest discriminating power. Herring gull productivity at all colonies (1-1.7 young gulls/pair) was normal and showed no significant geographical variation. Eggshell thickness was greatest in colonies in the Sandusky Basin and least in colonies in the Detroit River and extreme west end of the lake; mean eggshell thickness was 0.350 +/- 0.02 mm (6.7% thinning), which was weakly, but significantly correlated to DDE concentration. The variation in contaminants in herring gull eggs on a basin basis (i.e. Western, Eastern, Sandusky, etc.) paralleled

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those known for sediments, water and fish. In addition to its role as an indicator of lake-wide contamination of the Great Lakes, the herring gull may function as an indicator of 'regional' contamination. This improves the geographical specificity of the herring gull as an indicator species on the Great Lakes, where it is a non-migratory species. (Author's abstract)  
W91-01454

**PARAFFIN HYDROCARBONS IN THE GONADS OF THE SEA URCHIN *STRONGYLOCENTROTUS NUDUS* NORMALLY AND AFTER EXPOSURE TO DIESEL OIL (IN RUSSIAN).**  
Akademiy Nauk SSSR, Vladivostok. Inst. Biologii Morya.  
M. A. Vashchenko, and V. I. Svetashev.  
Biologiya Morya BIMOD4, No. 5, p 61-67, 1989. 3 fig. 1 tab, 28 ref.

Descriptors: \*Aliphatic hydrocarbons, \*Animal tissues, \*Bioaccumulation, \*Echinoderms, \*Oil pollution, \*Path of pollutants, \*Tissue analysis, Gas chromatography, Laboratory methods.

The accumulation of paraffin hydrocarbons in the gonads of the sea urchin *Strongylocentrotus nudus* exposed to the water soluble fraction (WSF) of light diesel oil was determined using gas chromatography. In the male and female gonads of the sea urchins from the control group (before exposure) and the experimental group (exposed to WSF of light diesel oil for 1, 3, 7, and 15 days) a homologous series of n-paraffins over the range of C15-C28 and C13-C28, respectively, was found. Gas chromatograms of n-alkanes isolated from the gonads of experimental animals showed a greater unresolved peak and the presence of isoalkanes in the C14-C28 range not found in controls. These isoalkanes were identical to those from WSF of diesel oil. The qualitative composition of n-paraffins over the C19-C28 range was similar for both the control and experimental sea urchins. Hydrocarbon levels in the gonads of experimental animals were 5-20 times higher than in controls. n-Alkane concentration was maximal in male gonads the day after exposure. It was concluded that the gonads of sea urchins exposed to WSF of light diesel oil accumulate hydrocarbons. (Author's abstract)  
W91-01456

**MONITORING THE EROSION OF AN EXPRESSWAY DURING ITS CONSTRUCTION: PROBLEMS AND LESSONS.**  
Macquarie Univ., North Ryde (Australia). School of Earth Sciences.  
For primary bibliographic entry see Field 2J.  
W91-01459

**SEASONAL DESCRIPTION OF THE QUALITY AND QUANTITY OF SNOWMELT IN A MOUNTAINOUS REGION USING AN INTEGRATED MODEL.**  
Slovenska Akademia Vied, Bratislava (Czechoslovakia). Ustav Hydrologie a Hydrometeorologie.  
For primary bibliographic entry see Field 2C.  
W91-01460

**RELEASE OF CATIONIC ALUMINIUM FROM ACIDIC SOILS INTO DRAINAGE WATER AND RELATIONSHIPS WITH LAND USE.**  
University Coll. of Wales, Aberystwyth. Soil Science Unit.  
W. A. Adams, A. Y. Ali, and P. J. Lewis.  
Journal of Soil Science JSSCAH, Vol. 41, No. 2, p 255-268, June 1990. 5 fig, 10 tab, 24 ref.

Descriptors: \*Acid rain, \*Acidic soils, \*Aluminum, \*Cation exchange, \*Drainage water, \*Leachates, \*Soil chemistry, \*Solute transport, \*Acidic water, \*Cations, \*Chemical interactions, \*Hydrogen ion concentration, \*Ion exchange, \*Land use, \*Leaching, \*Nitrates, \*Rainfall, \*Stream discharge, \*Sulfates, \*Wales.

Aluminum is usually the dominant exchangeable cation in strongly acidic soils. The concentration of cationic monomeric aluminum (Al(+3)) was determined in streams draining areas of different

land use in Wales. Relationships between the concentrations of Al(+3) and companion ions were examined both for streams and for eluates from soil leached in the laboratory with simulated rainwater that ranged in pH and salt concentration. The concentrations of Al(+3) were consistently greater in streams draining Sitka spruce woodland than in streams in adjacent catchments draining rough grazing. In no case was the Al(+3) concentration governed by the solubility product of gibbsite. The concentrations of Al(+3) were very closely correlated with excess anions (total inorganic anions minus basic cations) both for stream water and for eluates from soil leached with simulated rainwater at a constant pH equal to that of the soil (3.8). Exchangeable Al was the source of Al(+3) in leachates from soil in the laboratory. The displacement of exchangeable Al was the dominant process accounting for the levels of Al(+3) in acidic streams. Hydrogen ions were much more important than basic cations in displacing exchangeable Al from the acidic soil used in the laboratory experiments, and probably from soils in the field. The greater excess of inorganic anions in streams from Sitka spruce woodland probably resulted from a greater anion excess in the input water (acid rain) together with a greater NO<sub>3</sub> production in the soil. All three major anions—Cl<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, and NO<sub>3</sub><sup>-</sup>—contributed to the greater anion excess. (Author's abstract)  
W91-01479

**UPGRADING ANTIQUE SEWERS.**  
Massachusetts Water Resources Authority, Boston.  
K. O'Brien, F. J. Killilea, and S. T. Johnson.  
Civil Engineering (ASCE) CEWR9A, Vol. 60, No. 9, p 58-60, September 1990. 2 fig.

Descriptors: \*Civil engineering, \*Metropolitan water management, \*Pumping plants, \*Sewer systems, \*Upgrading, Boston, Construction methods, Siphons, Urban areas, Water treatment facilities.

People in Boston and surrounding communities expect their public works systems to keep pace with their needs through periodic extension, revision, rehabilitation, and repair. In the most recent project, a \$35 million, four-year program, the Massachusetts Water Resources Authority completely restructured the pumping system of the North Metropolitan Sewerage System which required that the existing system serve as building blocks for the new system, which will meet the area's needs through the year 2000. Two major components of the upgraded system are the new pump station and screen house. Design and construction challenges for these components, and for the conduits and connections required to integrate them into the overall system, were compounded by site constraints and the need to keep the existing system operating throughout construction. Construction of the new pump station required a number of diversions, new conduits, and connections as well as modifications to existing facilities. The new pump station was sited near the existing station for easy connection to the two siphons and two sewers that would deliver flows to it. Junction chambers were constructed around the sewers and siphons; as each chamber was completed, the sewers were reactivated until station startup. The screen house required a number of diversions and bypasses. Again, junction chambers were constructed and flows were diverted during construction and then back to their original locations. When the system is brought on-line, its capacity of 125 mgd will meet the needs of the area for the rest of the decade. (Fish-PTT)  
W91-01484

**PIRLA PROJECT (PALEOECOLOGICAL INVESTIGATION OF RECENT LAKE ACIDIFICATION): AN INTRODUCTION TO THE SYNTHESIS OF THE PROJECT.**  
Indiana Univ. at Bloomington. Dept. of Biology.  
D. R. Whitehead, D. F. Charles, and R. A. Goldstein.  
Journal of Paleolimnology JOUPE8, Vol. 3, No. 3, p 187-194, 1990. 4 fig, 20 ref, append. Electric Power Research Institute fund RP-2174-10.

Descriptors: \*Acid rain, \*Lake acidification, \*Lake basins, \*Limnology, \*North America, \*Paleolimnology, Acid lakes, Adirondack Mountains, Biochemistry, Chemical properties, Cores, Florida, Geochemistry, Great Lakes, New England, Regional analysis, Research priorities.

The Paleoeological Investigation of Recent Lake Acidification (PIRLA) project was designed to assess the magnitude and character of the impact of acid precipitation on North American lake systems. The scenario that stimulated the project is straightforward: there is an obvious spatial pattern of acidic deposition in North America; a significant amount of acidic deposition falls on areas whose bedrock and surficial geology imbue them with high potential sensitivity to acid precipitation; and reconstruction of SO<sub>2</sub> and NO<sub>x</sub> emissions for North America indicate a significant increase in emissions after 1900, and distinct patterns of emission density. The paleolimnological record can provide accurate and detailed information on the biogeochemical trajectories of lake systems: patterns of chemical and biological change that can be read on different scales. The regional research teams, areas to be studied, methods to be utilized, and questions to be approached were developed in intensive discussions among the collaborators in a meeting held in 1983. The areas focused upon include: Adirondack region, Northern New England, Northern Great Lakes States, and Northern Florida. The questions studied in each geographic region addressed evidence of lake acidification in this century; the magnitude, character, and timing of the response; and the relative roles of natural and anthropogenic sources of acidity. The primary message of PIRLA clearly lies in the regional summaries, which provide an interdisciplinary and integrated view of recent acidification trends in each region. (See W91-01499 thru W91-01502) (Fish-PTT)  
W91-01498

**PALEOECOLOGICAL INVESTIGATION OF RECENT LAKE ACIDIFICATION IN THE ADIRONDACK MOUNTAINS, N.Y.**  
Indiana Univ. at Bloomington. Dept. of Biology.  
D. F. Charles, M. W. Binford, E. T. Furlong, R. A. Hites, and M. J. Mitchell.  
Journal of Paleolimnology JOUPE8, Vol. 3, No. 3, p 195-241, 1990. 11 fig, 4 tab, 148 ref, 3 append. Electric Power Research Institute fund RP-2174-10; National Science Foundation Grants BSR-8617622, DEB77-03907, and DEB79-12210; and U.S. EPA-North Carolina State University Acid Deposition Program fund APP-0199-1982.

Descriptors: \*Acid lakes, \*Acid rain, \*Acid rain effects, \*Adirondack Mountains, \*Cores, \*Lake acidification, \*Limnology, \*New York, \*Paleolimnology, Calcium, Chrysophyta, Diatoms, Fish, Manganese, Midge, Sediment analysis, Sulfur, Titanium, Water chemistry, Waterfleas, Watersheds.

The Paleoeological Investigation of Recent Lake Acidification (PIRLA) project prompted analysis of the sediment record of 12 Adirondack lakes, revealing that the 8 clearwater lakes with current pH < 5.5 and alkalinity < 10 microeq/L have acidified recently. The onset of this acidification occurred between 1920 and 1970. Loss of alkalinity, based on diatom assemblages, ranged from 2 to 35 microeq/L. The acidification trends are substantiated by stratigraphies of diatom, chrysophyte, chironomid, and cladoceran remains, Ca:Ti and Mn:Ti ratios, sequentially extracted forms of Al, and historical fish data. Acidification trends appear to be continuing in some lakes, despite reductions in atmospheric sulfur loading that began in the early 1970s. The primary cause of the acidification trend is clearly increased atmospheric deposition of strong acids derived from the combustion of fossil fuels. Natural processes and watershed disturbances cannot account for the changes in water chemistry that have occurred, but they may play a role. Sediment core profiles provide a clear record of increased atmospheric input of materials associated with the combustion of fossil fuels beginning in the late 1800s and early 1900s. The primary evidence for acidification occurs after that period, and the pattern of water chemistry response to

## Sources Of Pollution—Group 5B

increased acid inputs is consistent with current understanding of lake-watershed acidification processes. (See W91-01498 thru W91-01502) (Author's abstract)  
W91-01499

**SEQUENTIALLY EXTRACTED METALS IN ADIRONDACK LAKE SEDIMENT CORES.**  
Indiana Univ., Bloomington. School of Public and Environmental Affairs.  
For primary bibliographic entry see Field 2H.  
W91-01500

**CALCULATION AND UNCERTAINTY ANALYSIS OF PB210 DATES FOR PIRLA PROJECT LAKE SEDIMENT CORES.**  
Harvard Univ., Cambridge, MA. Dept. of Landscape Architecture.  
For primary bibliographic entry see Field 2H.  
W91-01501

**UTILITY OF SCALED CHRYSOPHYTES FOR INFERRING LAKEWATER PH IN NORTHERN NEW ENGLAND LAKES.**  
Queen's Univ., Kingston (Ontario). Dept. of Biology.  
For primary bibliographic entry see Field 2H.  
W91-01502

**MOMENTARY INSTABILITY OF A SATURATED POROUS LAYER WITH A TIME-DEPENDENT TEMPERATURE DISTRIBUTION, AND THE MOST UNSTABLE DISTURBANCE.**  
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.  
T. Green.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 2015-2021, September 1990. 7 fig, 13 ref.

Descriptors: \*Convection, \*Groundwater movement, \*Groundwater pollution, \*Path of pollutants, Mathematical analysis, Porous media, Temperature gradient.

The stability of fluid with a time-dependent vertical temperature distribution in a horizontal, saturated porous layer is investigated, using the idea of momentary stability and a Galerkin technique. The most unstable disturbance is found by minimizing the critical Rayleigh number over the Fourier amplitudes of that disturbance, using both an iterative and a simplex procedure. As an example, the case in which an originally linear, stable temperature distribution is changed by lowering the temperature of the upper boundary at a constant rate is examined in detail. It showed that the most unstable disturbance is usually large where the base state is gravitationally unstable but there seems to be no simple relation between the two. (Peters-PTT)  
W91-01518

**SOLUTE TRANSPORT WITH MULTISEGMENT, EQUILIBRIUM-CONTROLLED REACTIONS: A FEED FORWARD SIMULATION METHOD.**  
Geological Survey, Menlo Park, CA. Water Resources Div.  
J. Rubin.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2029-2055, September 1990. 8 fig, 12 tab, 22 ref, append.

Descriptors: \*Feed forward method, \*Geochemistry, \*Mathematical analysis, \*Path of pollutants, \*Solute transport, \*Water chemistry, Chemical reactions, Computer models.

The feed forward method (FF method) is used to formulate operational equations which simulate transport of solutes influenced by equilibrium-controlled reaction networks. The FF method provides increased solution efficiency by adapting its formulations to some of the network's fundamental features. The FF method has been further developed by adapting and testing it for a variety of network conditions. Classes of homogeneous, classical heterogeneous, and ion exchange network segments were studied. Networks may contain

only a single class of segments or they may involve two or three segment classes. The FF method was found to be applicable to all the cases tested. In one of these cases, for the more complex configurations of network segments, the FF method did not attain all of its objectives. A systematic, stepwise approach to method development was used. It revealed, for certain subnetworks, an a priori inadmissibility, irrespective of the method used, and, for some other networks, an a priori irrelevance to transport dynamics. It also demonstrates that when certain subnetworks, belonging to different segment classes, form a single network, synergism (or antagonism) may occasionally arise and decrease (or increase) the difficulty of solving the transport problem. (Author's abstract)  
W91-01520

**MASS ARRIVAL OF SORPTIVE SOLUTE IN HETEROGENEOUS POROUS MEDIA.**  
Royal Inst. of Tech., Stockholm (Sweden).  
V. D. Cvetkovic, and A. M. Shapiro.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2057-2067, September 1990. 5 fig, 23 ref.

Descriptors: \*Groundwater movement, \*Mathematical analysis, \*Path of pollutants, \*Porous media, \*Solute transport, \*Water chemistry, Desorption, Hydraulic conductivity, Solutes, Sorption, Tracer studies.

The stochastic arrival time analysis of nonreactive solute movement in heterogeneous porous media was extended to consider solutes that undergo sorption-desorption governed by first-order linear kinetics. For an instantaneous solute injection, a general expression for the expected mass flux at any distance from the injection point was derived in terms of the three-dimensional velocity field and the forward-sorption and reverse-sorption rate coefficients. This general expression is reduced for three special cases: (1) equilibrium sorption-desorption where the retardation coefficient is either correlated or uncorrelated with the hydraulic conductivity field, (2) solute degradation where the rate coefficient is uncorrelated with the hydraulic conductivity, and (3) nonequilibrium sorption-desorption with constant sorption rate coefficients. These cases were analyzed for a lognormally distributed and statistically isotropic spatial correlation of the hydraulic conductivity; other assumptions of spatial correlation in the hydraulic conductivity can also be used. The influence of spatial variability in the sorption rate coefficients for nonequilibrium sorption-desorption was investigated for the special case of a stratified porous medium. For equilibrium sorption-desorption, the spatial variability in the retardation coefficient may notably delay the breakthrough of solute at a given location. The spatial variability in the degradation parameter does not influence solute breakthrough significantly for the considered range of parameters. For a stratified porous medium, spatial variability in the sorption rate coefficients has a significant effect on the cumulative mass arrival at a given location. Using the harmonic mean of the sorption rate coefficients most closely approximates the results generated using variable sorption-rate coefficients for the stratified formation case. (Author's abstract)  
W91-01521

**MEAN SQUARE ERROR OF REGRESSION-BASED CONSTITUENT TRANSPORT ESTIMATES.**  
Geological Survey, Reston, VA.  
E. J. Gilroy, R. M. Hirsch, and T. A. Cohn.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2069-2077, September 1990. 9 fig, 12 ref, append.

Descriptors: \*Model studies, \*Network design, \*Path of pollutants, \*Regression analysis, \*Sampling, \*Solute transport, Errors, Flow equations, Mathematical models, Surface water.

Estimates of long-term transport of constituents commonly are obtained by summing retransformed estimates from regressions of logarithmically transformed response variables. Typical explanatory

variables for these regressions include functions of flow, change in flow, time, and time of year. The mean and mean square error of four estimators of long-term transport at periodically measured stations are presented as a function of the observed values of the explanatory variables from the long-term record and summary statistics of the regression data. Estimates of the mean square errors can be used in designing sampling strategies to attempt to minimize the uncertainty in the estimation of long-term transport subject to a constraint on the number of samples to be taken. This uncertainty is expressed in terms of the explanatory variables in the long-term record, the regression coefficients and standard error of the regression and the mean and covariance structure of the explanatory variables used in the regression. (Author's abstract)  
W91-01522

**STREAM FUNCTIONS AND EQUIVALENT FRESHWATER HEADS FOR MODELING REGIONAL FLOW OF VARIABLE-DENSITY GROUNDWATER. 1. REVIEW OF THEORY AND VERIFICATION.**  
Texas Univ. at Austin. Bureau of Economic Geology.  
For primary bibliographic entry see Field 2F.  
W91-01524

**STREAM FUNCTIONS AND EQUIVALENT FRESHWATER HEADS FOR MODELING REGIONAL FLOW OF VARIABLE-DENSITY GROUNDWATER. 2. APPLICATION AND IMPLICATIONS FOR MODELING STRATEGY.**  
Texas Univ. at Austin. Bureau of Economic Geology.  
For primary bibliographic entry see Field 2F.  
W91-01525

**PHYSICALLY BASED MODEL FOR PREDICTING SOLUTE TRANSFER FROM SOIL SOLUTION TO RAINFALL-INDUCED RUNOFF WATER.**  
Agricultural Research Service, Riverside, CA. Salinity Lab.  
R. Wallach, and M. T. van Genuchten.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 2119-2126, September 1990. 8 fig, 2 tab, 15 ref, append.

Descriptors: \*Agricultural runoff, \*Model studies, \*Nonpoint pollution sources, \*Path of pollutants, \*Rainfall-runoff relationships, \*Soil solution, \*Water pollution sources, Agricultural chemicals, Hydrographs, Infiltration, Infiltration rate, Mathematical models, Overland flow, Pesticides, Soil water, Solute transport.

A model was developed to predict the field outlet concentration hydrograph for chemicals released into overland runoff induced by continuous rainfall on a sloping soil. The model accounts for convective-dispersive solute transport in the soil and also considers rate-limited mass transfer through a laminar boundary layer at the soil surface/runoff water interface. Solute transport is assumed to be subject to linear equilibrium sorption onto the solid phase of the soil. Concentration hydrographs for rainfall-induced runoff were derived by treating the runoff zone as a well-mixed reactor characterized by an appropriate residence time distribution. The model was used to predict previously obtained experimental data for runoff from soil boxes with permeable bottoms. Good agreement was obtained between predicted and measured outflow concentrations for relatively low infiltration rates, provided relatively large dispersion coefficients were used in the calculations. Solute concentrations in the soil were also predicted well. Results for relatively high infiltration rates were less accurate, perhaps in part because of an incorrect assumption in the model that the infiltration rate remained constant in time and space during the runoff experiments. (Author's abstract)  
W91-01527

**THERMAL AND TROPHIC STABILITY OF DEEPER MAINE LAKES IN GRANITE WA-**

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

#### TERSHERDS IMPACTED BY ACID DEPOSITION.

Maine Univ. at Orono. Dept. of Geological Sciences.

For primary bibliographic entry see Field 5C.  
W91-01530

#### APPROXIMATE SOLUTIONS FOR CATION TRANSPORT DURING UNSTEADY, UNSATURATED SOIL WATER FLOW.

Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Soils.  
For primary bibliographic entry see Field 2G.  
W91-01535

#### STATISTICAL CHARACTERISTICS OF SOME ESTIMATORS OF SEDIMENT AND NUTRIENT LOADINGS.

Instituto de Pesquisas Hidraulicas, Porto Alegre (Brazil).  
For primary bibliographic entry see Field 2J.  
W91-01538

#### EVALUATING GROUND-WATER VULNERABILITY TO PESTICIDES.

Woodward-Clyde Consultants, Oakland, CA.  
Y. J. Meeks, and J. D. Dean.  
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 693-707, September/October 1990. 4 fig, 2 tab, 15 ref.

Descriptors: \*Agricultural engineering, \*Ground-water management, \*Groundwater pollution, \*Path of pollutants, \*Pesticides, \*Water resources management, \*Advection, \*California, \*Dispersion, \*Hydrologic properties, \*Leaching, \*Recharge, \*Solute transport, \*Wells.

A methodology was developed to rank the relative vulnerability of groundwater areas to contamination by agriculturally-applied pesticides. The method uses the advection-dispersion equation for chemical transport in soils to develop the leaching potential index (LPI), which is an indicator of the relative susceptibility of each area. The index incorporates the effects of depth to groundwater, natural and irrigation recharge rates, absorption, and chemical decay. The importance (weighting) of the hydrological factors is physically-based, not subjective as it is in a number of approaches reviewed. The weights are not required to have constant values, as is typical of other methodologies; they are instead dependent on the specific chemical properties of the pesticide under consideration. This methodology was verified by comparing the LPI scores estimated for a 381-sq mi (987-sq km) area located in the San Joaquin Valley, California, with available data on 1,2-dibromochloropropane (DBCP) contamination in groundwater in the same area. The percentage of wells in which DBCP was detected in these square-mile sections was positively correlated with the computed LPI scores for each section, i.e., sections having higher LPI scores tended to have wells with more frequent positive detections of DBCP. This is the first time that such a large-scale verification of similar ranking procedures has been demonstrated, and it will be a useful planning tool for early identification of agricultural areas susceptible to groundwater contamination and efficient management of sampling resources. (Fish-PTT)  
W91-01558

#### STUDY OF POLLUTANT DIFFUSION IN THE JIUJIANG SEGMENT OF THE CHANGJIANG RIVER (IN CHINESE).

Academia Sinica, Qingdao (China). Inst. of Oceanology.  
P. Q. Li, L. T. Miao, D. Y. Xia, and X. Y. Wang.  
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 2, p 144-153, March 1990. 8 fig, 5 tab, 5 ref. English summary.

Descriptors: \*China, \*Diffusion, \*Path of pollutants, \*Tracers, \*Yangtze River, \*Changjiang River, \*Diffusion coefficient, \*Dye releases, \*Jiujiang, \*Marine pollution, \*Surveys, \*Water quality.

Diffusion in the Changjiang river (Yangtze river) was studied using the fluorescent dye Rhodamine-

B as a tracer and a fluorimeter developed by the authors. The results of this study indicated: 1) The Jiujiang port and the region downstream is a straight segment of river and the mean velocity of the water is about 0.5 m/s. The scale of diffusion for 6 kg of Rhodamine-B is 3240 m. 2) The diffusion of a pollutant is rapid even when the winds are moderate, and the dilution factor (DF) varies from one hundred to ten billion within 40 minutes. When there is a strong breeze or the water is disturbed by shipping, the diffusion rate of the pollutant is higher. A six to seven order magnitude of change can occur in about ten minutes after the pollutant is discharged. The pollutant is soon diluted below the level required for good water quality and serious pollution does not occur when minor pollutants are discharged. 3) The log of the concentration of Rhodamine-B is equal to a constant minus 2.9 times the log of the time, so the log of concentration is linear with the log of time and the concentration decreases rapidly. 4) The diffusion coefficient of the river water is 1.23 square m/s in the Jiujiang region. The results show that the diffusion rate of the river is generally more rapid than diffusion in the sea, and the diffusion rate is increased by the disturbance of shipping. However, this increase in the diffusion coefficient is not typical of fresh water in the Jiujiang region. 5) A gradient exists for the water current in the Jiujiang segment of the river which causes an eddy current and enhances exchange between surface and bottom water. The distribution of pollutants into the deeper waters of the river is accelerated by this eddy. Therefore a soluble pollutant can reach the drinking water intake for Jiujiang within five minutes, so the discharge of pollutants from the foreign trade area of the port must be limited. (Author's abstract)  
W91-01571

#### ACCUMULATION OF HEAVY METALS AND THE VARIATION OF AMINO ACIDS AND PROTEIN IN EICHORNIA CRASSIPES (MART.) SOLMS IN THE DIANCHI LAKE (IN CHINESE).

Academia Sinica, Beijing (China). Research Center for Eco-Environmental Sciences.  
Y. X. Lin, and X. M. Zhang.  
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 2, p 179-184, March 1990. 3 tab, 15 ref. English summary.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*China, \*Heavy metals, \*Marsh plants, \*Path of pollutants, \*Amino acids, \*Cadmium, \*Dianchi Lake, \*Lead, \*Organic pollutants, \*Proteins.

The accumulation of heavy metals (Cu, Cd, Hg, and As) by *Eichhornia crassipes* (Mart.) Solms in the water of Dianchi Lake in Kunming and the variation of the protein and amino acid content were studied. The analytical results of the experiment indicate that *Eichhornia crassipes* (Mart.) Solms has a good accumulative coefficient for heavy metals. The highest concentration factors were 16,190 for Pb and 14,285 for Cd. The analysis of different parts of the plant showed that the accumulation in the root system is several times higher than the accumulation in the stems and leaves. This may result from the fact that the fibrous root system with its high contact area with water has high absorption capacity, and at the same time microbes adhering to the root system increase the accumulation. The content of protein and amino acids are relatively low in *Eichhornia crassipes* (Mart.) Solms growing in the water with higher levels of heavy metals. The content of protein in *Eichhornia crassipes* (Mart.) Solms is 38.35%, the content of amino acids 32%. There are 16 kinds of amino acids in *Eichhornia crassipes* (Mart.) Solms, not including tryptophan, cysteine and cystine which were not determined. *Eichhornia* can not only purify sewage, but can also serve as good forage and raw material for paper making as well as bio-energy. In utilizing *Eichhornia* for forage, the concentration of heavy metals and organic pollutants found in the *Eichhornia crassipes* (Mart.) Solms must be considered. (Author's abstract)  
W91-01572

#### INDUCTION OF HEPATIC MIXED-FUNCTION OXIDASE OF THE MULLET, MUGIL SO-LUY BY CRUDE OIL (IN CHINESE).

Academia Sinica, Qingdao (China). Inst. of Oceanology.  
For primary bibliographic entry see Field 5C.  
W91-01573

#### POISON RUNOFF: NEW ANSWERS TO A PERVERSIVE PROBLEM.

Natural Resources Defense Council, Inc., Washington, DC.  
For primary bibliographic entry see Field 5G.  
W91-01623

#### TRIBUTYL TIN AND INVERTEBRATES OF A SEAGRASS ECOSYSTEM: EXPOSURE AND RESPONSE OF DIFFERENT SPECIES.

Cornell Univ., Ithaca, NY. Ecosystems Research Center.  
For primary bibliographic entry see Field 5C.  
W91-01625

#### ENVIRONMENTAL FACTORS AFFECTING BENTHIC INFAUNAL COMMUNITIES OF THE WESTERN ARABIAN GULF.

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Research Inst.  
For primary bibliographic entry see Field 2L.  
W91-01626

#### SEASONAL VARIATION OF THERMOPHILIC CAMPYLOBACTERS IN SEWAGE SLUDGE.

Lancaster Univ. (England). Dept. of Biological Sciences.  
K. Jones, M. Betaieb, and D. R. Telford.  
Journal of Applied Bacteriology JABAA4, Vol. 69, No. 2, p 185-189, August 1990. 1 fig, 3 tab, 12 ref.

Descriptors: \*Bacteria, \*Bacterial analysis, \*Campylobacter, \*Digested sludge, \*Microorganisms, \*Pathogenic bacteria, \*Seasonal variation, \*Sludge, \*Sludge analysis, \*England, \*Fate of pollutants, \*Monitoring, \*Sludge disposal, \*Sludge utilization, \*Wastewater, \*Wastewater treatment.

The seasonal variation of thermophilic campylobacters in sewage sludge was studied over a 21 month period. The numbers in fresh sludge (from primary sedimentation) vary between approximately 200 and 5000/100 ml for most of the year but there was a large increase in May and June (in May 1988 there were 42,100 campylobacters/100 ml which is 17 times more than in the preceding April). In 1989 there was a similar May/June peak but with lower numbers. This seasonal variation, measured by environmental monitoring, reflects the incidence of infections in the community. The same pattern was found in 2-d old sludge but the numbers were substantially lower (40% lower over the experimental period). Thermophilic campylobacters were virtually absent from digested sludge and sludge prior to land distribution. Survival experiments confirm that campylobacters survive for only a few hours in both sterile and unsterile digested and undigested sludge. These results suggest that it is safe to dispose of Lancaster's digested sludge on land but there is still uncertainty about the ability of campylobacters to survive in sludge in the viable but non-culturable form. (Author's abstract)  
W91-01655

#### EFFECTS OF SUNLIGHT AND AUTOCHTHONOUS MICROBIOTA ON ESCHERICHIA COLI SURVIVAL IN AN ESTUARINE ENVIRONMENT.

Virginia Inst. of Marine Science, Gloucester Point. Dept. of Biological and Fisheries Sciences.  
M. W. Rhodes, and H. I. Kator.  
Current Microbiology CUMIDD, Vol. 21, No. 1, p 65-73, July 1990. 5 fig, 4 tab, 52 ref. NOAA Grant No. NA81AA-D-00025.

Descriptors: \*Chesapeake Bay, \*Enteric bacteria, \*Escherichia coli, \*Estuaries, \*Fate of pollutants,

## Sources Of Pollution—Group 5B

Cell mortality, Microbiological studies, Ultraviolet radiation.

The effects of sunlight and the indigenous microbiota on *Escherichia coli* survival were examined with membrane diffusion chambers deployed in Chesapeake Bay shellfish growing waters. Chambers, fitted with an 'upper' UV and visible light-transmitting copolymer film and 'lower' semipermeable polycarbonate membrane, were deployed parallel to the water surface to maximize light exposure. Maximum values of a coefficient describing changes in culturable cell densities after exposure to sunlight, were 1.7/h and 0.7/h in preliminary tank and in situ experiments, respectively. Mortality and sublethal stress, the latter measured with an electrochemical detection technique, were largest during the first 4 h of exposure. Owing to the light-attenuating properties of Chesapeake Bay water, light-induced cell mortality was significantly reduced at 0.25 m compared with surface exposed cells, and was undetected at 0.5-1.0 m except during seasons of maximal light penetration. Combined exposure to both sunlight and the autochthonous microbiota yielded significantly greater mortality than for either factor alone. (Author's abstract)

W91-01663

#### COMPARISON OF A GENE PROBE WITH CLASSICAL METHODS FOR DETECTING 2,4-DICHLOROPHENOXACETIC ACID (2,4-D) BIODEGRADING BACTERIA IN NATURAL WATERS.

Oregon State Univ., Corvallis. Dept. of Microbiology.

P. S. Amy, M. V. Staudacher, and R. J. Seidler. Current Microbiology CUMIDD, Vol. 21, No. 2, p 95-101, August 1990. 4 fig, 3 tab, 19 ref.

Descriptors: \*Biodegradation, \*Experimental data, \*Fate of pollutants, \*Herbicides, \*Pesticides, Colony hybridization, Gene probes, Marys River, Willamette River.

Colony hybridizations with a gene probe for enumeration of bacteria the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) were compared with classical enrichment and radiolabel most-probable-number (MPN) assay methods. UV scans of enrichment cultures revealed 2,4-D degradation with raw sewage occurred in 4-11 days, 4-22 days with Mary's River water, and 5-22 days with Willamette River water. 14C-2,4-D MPN analysis, measuring release of <sup>14</sup>CO<sub>2</sub>, yielded estimates of bacteria per milliliter able to degrade 2,4-D. Raw sewage estimates were 140,000 2,4-D degraders/ml, Mary's River water >160,000/ml, and Willamette River water 16,000/ml. Activities noted by UV scan enrichment data supported these results. Autoradiograms of colony blots were also used to estimate numbers of 2,4-D-degrading bacteria. These estimates were also supported by the UV scan data from enrichment cultures. Raw sewage gave counts between 50,000 and 290,000 2,4-D-degrading bacteria/ml, which correlates well with the estimates obtained by 14C-MPN analyses. River waters, both much lower in total bacteria counts and organic carbon than raw sewage, yielded fewer 2,4-D-degrading bacteria than estimated by 14C-MPN. Media composition and cometabolism may account for discrepancies in estimates for 2,4-D-degrading bacteria observed when colony blot and 14C-MPN analyses were compared. Replica plating made it possible to test for 2,4-D biodegradation from colonies reactive in autoradiograms. Five of 12 colonies reacting in the colony hybridization exhibited biodegradation activities. Nonreactive colonies failed to degrade 2,4-D. (Author's abstract)

W91-01664

#### ANALYTICAL ASYMPTOTIC SOLUTIONS FOR LONGITUDINAL DISPERSION WITH DEAD ZONES.

Contra Costa Water District, Concord, CA. For primary bibliographic entry see Field 8B. W91-01672

#### NITRATES IN GROUND WATER.

S. Chakravarty.

Water Resources Journal, No. 163, p 109-110, December 1989. 1 fig, 6 ref.

Descriptors: \*Groundwater pollution, \*India, \*Nitrates, \*Nitrogen removal, \*Nonpoint pollution sources, \*Water pollution control, \*Water pollution treatment, Agricultural chemicals, Agriculture, Biodegradation, Desalination, Dissolved solids, Fertilizers, Membrane processes.

A newly emerging problem in the field of groundwater quality is excessive nitrates arising from increased use of nitrogen fertilizers. A recent survey in India revealed that 1,290 groundwater samples from 11 States had a nitrate content more than 45 mg/L. Most were also found to have a high dissolved solids content. The standard technologies applied for desalination such as reverse osmosis and electrodialysis can also achieve the removal of nitrates. Natural decomposition of nitrates by bacteria can be successfully applied. In many cases, a combination of instantly implemented hydrological measures and agricultural measures adapted to local conditions would be the most suitable way to solve the problem of nitrate load. Close collaboration between the water supplying and agricultural sectors within the affected catchment areas is necessary. (Miller-PTT)

W91-01681

#### EFFECT OF ENVIRONMENTAL STORAGE CONDITIONS ON THE ORGANIC CONTENT OF SIMULATED COAL LEACHATES.

Maryland Univ., Solomons. Chesapeake Biological Lab.

For primary bibliographic entry see Field 5G. W91-01689

#### CAUSES OF TEMPORAL VARIABILITY OF LEAD IN DOMESTIC PLUMBING SYSTEMS.

Illinois State Water Survey Div., Champaign. Aquatic Chemistry Section.

M. R. Schock. Environmental Monitoring and Assessment EMASDH, Vol. 15, No. 1, p 59-82, July 1990. 8 fig, 6 tab, 38 ref. EPA Contracts 7W-7480-NASA and 7W-7425-NASX.

Descriptors: \*Lead, \*Pipelines, \*Statistical analysis, \*Temporal variation, \*Water pollution sources, Brass, Carbonates, Chlorine, Hydrogen ion concentration, Orthophosphates, Silicates, Solder, Water conveyance.

Sources of lead in drinking water are primarily lead pipe, lead/tin solder, and brass fixture materials. Lead levels in the water depend upon many solubility factors, such as: water pH, concentrations of substances such as inorganic carbonate, orthophosphate, chlorine, and silicate; temperature; and the nature of the pipe surface. Physical factors such as time and chemical mass transfer are also significant in governing lead levels in non-equilibrium systems. Analytical variability is not particularly significant relative to between-site and within-site variability. Knowledge of temporal variability at each site is necessary to define a statistically valid monitoring program. An analysis of published data covering repetitive measurements at a given site show that the variability of lead concentration at each site tends to be characterized by the frequent occurrence of spikes. Variability expressed as approximate relative standard deviations tend to be about 50-75% in untreated water, regardless of the mean lead concentration. The distributions are frequently not normal for small numbers of samples. Monitoring programs must incorporate controls for the causes of the within-site and between-site variability into their sampling design. The determination of necessary sampling frequency, sample number and sample volume must be made with consideration of the system variability, or the results will be unrepresentative and irreproducible. (Author's abstract)

W91-01698

#### TRIAZINE HERBICIDE FATE IN A NO-TILLAGE CORN (ZEA MAYS L.)-CROWNVELTCH (CORONILLA VARIA L.) 'LIVING MULCH' SYSTEM.

Pennsylvania State Univ., University Park. Dept. of Agronomy.

J. K. Hall, and N. L. Hartwig.

Agriculture, Ecosystems and Environment AEENDO, Vol. 30, No. 3/4, p 281-293, April 1990. 2 fig, 28 ref.

Descriptors: \*Crownvelvet, \*Herbicides, \*Maize, \*Mulches, \*Path of pollutants, \*Soil contamination, \*Triazine herbicides, Agriculture, Clay loam, Leaching, Pollutant identification, Soil analysis, Soil types.

Chloro-s-triazine herbicide distribution, dissipation and leaching potential were examined in two untilled soils planted to corn (*Zea mays* L.) in a crownvelvet (*Coronilla varia* L.) 'living mulch' sod. Herbicides studied were simazine (6-chloro-N,N'-diethyl-1,3,5-triazine-2,4-diamine), atrazine, cyanazine and procaryazine. Each was applied at 2.2 and 4.5 kg (active ingredient)/ha. Soil profiles were sampled twice yearly in 15 cm increments to 91 or 122 cm deep. These soil fractions were analyzed for parent herbicide residues. Herbicide dissipation and translocation were rapid and extensive under no-tillage management, and herbicide distribution in the different soil profiles was not predictable solely on the basis of water solubility of the chemicals or soil texture. The probability of detecting subsoil levels of these herbicides was as great in the Murrill silty clay loam as in the Morrison sandy loam tested. Simazine and atrazine were more persistent and detected more frequently at lower profile depths than cyanazine and procaryazine, which are considerably more water soluble. Redistribution of simazine and atrazine by leaching from early to mid-season was also more evident in each soil. (Author's abstract)

W91-01709

#### EXAMINATION OF THE RANGE OF COPPER COMPLEXING LIGANDS IN NATURAL WATERS USING A COMBINATION OF CATHODIC STRIPPING VOLTAMMETRY AND COMPUTER SIMULATION.

Water Research Centre, Medmenham (England). Medmenham Lab.

S. C. Apte, M. J. Gardner, J. E. Ravenscroft, and J. A. Turrell.

Analytica Chimica Acta ACACAM, Vol. 235, No. 2, p 287-297, August 15, 1990. 4 fig, 3 tab, 17 ref.

Descriptors: \*Chemical analysis, \*Copper compounds, \*England, \*Estuaries, \*Heavy metals, \*Pollutant identification, \*Voltammetry, \*Water analysis, Analytical methods, Metal complexes, Organic compounds, Salinity, Water quality control.

Knowledge of the detection capabilities of speciation techniques, gained by calculation and computer simulation, can be combined with experimental measurements to arrive at an understanding of trace metal speciation which is less dependent on operational factors than other approaches. Surface-water samples were collected from the Humber Estuary and its tributaries in two surveys carried out in November 1988 and October 1989. Some supplementary river samples were also taken in February 1990. The sampling sites were chosen primarily to obtain information on freshwater inputs and to obtain a broad range of estuarine salinities. Although concentrations of total dissolved copper can approach the estuarine Environmental Quality Standard value of 5 microgram/L, there is evidence of a substantial excess of complexing ligands at all locations except the outer estuary, where copper levels are much reduced by dilution. Dissolved copper is therefore present almost totally in the form of organic complexes. The range of different types of ligand is also assessed. In sea water there appears to be a range of ligands of differing affinities for copper; the complexing capacity ranges from 20 nM (conditional stability complex of the copper complex (K') > 10 raised to the fourteenth power) to 70 nM (K' > 10 raised to the eighth power). For estuarine samples, ligands with a high affinity for copper seem to be predominant and the overall complexing capacity rises to over 200 nM. In freshwater samples, it is likely that the potential for varying combinations of weak and strong complexes will depend on the

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water quality, but a capacity to complex over 200 nM copper is not unusual. (Author's abstract) W91-01715

#### ROLE OF AMMONIUM AND NITRATE RETENTION IN THE ACIDIFICATION OF LAKES AND FORESTED CATCHMENTS.

Ontario Ministry of the Environment, Dorchester. Dorset Research Center.  
P. J. Dillon, and L. A. Molot.  
Biogeochemistry BIOGEP, Vol. 11, No. 1, p 23-43, September 1990. 6 fig, 8 tab, 57 ref.

Descriptors: \*Acid rain, \*Acidification, \*Ammonium, \*Chemistry of precipitation, \*Forest watersheds, \*Lakes, \*Nitrates, \*Ecosystems, Freshwater, Nitrogen, Path of pollutants, Streams, Surface water.

The relative contribution of  $\text{HNO}_3$  to precipitation acidity in Eastern Canada has increased in recent years leading to some concern that the relative importance of  $\text{NO}_3^-$  deposition in acidification of terrestrial and aquatic ecosystems may increase. To gauge the extent of this impact, annual mass balances for  $\text{NO}_3^-$  and  $\text{NH}_4^+$  were calculated for several forested catchments and lakes in Ontario. Retention of  $\text{NH}_4^+$  by forested catchments was consistently high compared to retention of  $\text{NO}_3^-$  which was highly variable. Retention of inorganic nitrogen was influenced by catchment grade and areal water discharge. In lakes, the reciprocals of retention of  $\text{NO}_3^-$  and  $\text{NH}_4^+$  were linearly related to the ratio of lake mean depth to water residence time and retention time did not appear to be a function of degree of acidification of the lakes. Net N consumption-based acidification of lakes, defined as the ratio of annual  $\text{NH}_4^+$  mass to  $\text{NO}_3^-$  mass consumption, was negatively correlated with the areal water discharge and N consumption-related acidification was most likely to occur when the areal water discharge was  $<1.5 \text{ m/yr}$ . If retention mechanisms are unaffected by changes in deposition, changes in deposition will still result in changes in surface water concentrations although the changes will be of similar proportions. Therefore, ' $\text{NO}_3^-$  saturation' should not be defined by concentrations alone, but should be defined as decreasing long-term, average  $\text{NO}_3^-$  retention in streams and lakes in response to long-term increases in  $\text{NO}_3^-$  deposition. Analysis of survey data will be facilitated by grouping lakes and catchments according to similar characteristics. (Author's abstract) W91-01718

#### METHANE EMISSIONS FROM FEN, BOG AND SWAMP PEATLANDS IN QUEBEC.

McGill Univ., Montreal (Quebec). Dept. of Geography.  
T. R. Moore, and R. Knowles.  
Biogeochemistry BIOGEP, Vol. 11, No. 1, p 45-61, September 1990. 4 fig, 5 tab, 40 ref.

Descriptors: \*Air pollution sources, \*Bogs, \*Fens, \*Global warming, \*Limnology, \*Methane, \*Methanogenesis, \*Quebec, \*Swamps, \*Wetlands, Aerobic conditions, Anaerobic conditions, Climatic zones, Peat, Seasonal variation, Topography.

A static chamber technique was used weekly from spring thaw to winter freezing to measure methane emissions from ten sites representing subarctic fens and temperate swamps and bogs. Rates of  $<200 \text{ mgCH}_4/\text{sq m d}$  were recorded in subarctic fens: within-site emissions were primarily controlled by the evolution of the peat thermal regime, though significant releases during spring thaw were recorded at some sites. Between subarctic fens, topography and water table elevation were important controls on methane emissions, with the general sequence: pool = horizontal fen > string. Emission rates from the two swamp sites were lower ( $<20 \text{ mg CH}_4/\text{sq m d}$ ), except during the spring thaw and when the sites were saturated. The low water table ( $<80 \text{ cm}$  depth) in anomalously dry years reduced emission rates; rates were also low from a swamp site which had been drained and cleared of vegetation for horticulture. Methane emission rates were also low ( $<5 \text{ mg CH}_4/\text{sq m d}$ ) from 2 ombrotrophic bog sites. Laboratory

measurements of rates of methane production under anaerobic conditions and methane consumption under aerobic conditions revealed that production rates were generally highest in the surface layers (0 to 25 cm depth); production was high in the fens and very low in the bogs. The swamp samples were able to produce methane under anaerobic conditions, but were also able to consume methane under aerobic conditions. Annual methane emission rates are estimated to be 1 to 10  $\text{g CH}_4/\text{sq m}$  from the fens, 1 to 4  $\text{g CH}_4/\text{sq m}$  from the swamps and  $<0.2 \text{ g CH}_4/\text{sq m}$  from the bogs and drained swamp. (Author's abstract) W91-01719

#### FATE OF CATIONIC SURFACTANTS IN THE MARINE ENVIRONMENT: I. BIOCONCENTRATION OF LONG-CHAIN ALKYLNITRILES AND TRIALKYLAMINES.

Centro de Investigación y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry.  
M. Valls, P. Fernandez, and J. M. Bayona.  
Chemosphere CSMHAF, Vol. 19, No. 12, p 1819-1827, 1989. 5 fig, 1 tab, 21 ref.

Descriptors: \*Alkyl nitriles, \*Bioaccumulation, \*Biological magnification, \*Cationic surfactants, \*Path of pollutants, \*Spain, \*Surfactants, \*Trialkylamines, Analytical methods, Fate of pollutants, Industrial wastes, Pollutant identification, Polycyclic aromatic hydrocarbons, Sediment analysis, Toxicology.

The occurrence of cationic surfactants in the environment, which account for 10% of the total industrial output, has not been addressed until very recently. It is proposed that the long-chain alkylamines (TAMs) be used as conservative tracers of this class of surfactants because they have been found widely distributed in the aquatic environment but their ecotoxicological implications still remain unknown. The bioconcentration of the (TAMs) and long-chain alkyl nitriles (LANs), both of which are present as impurities in surfactant formulations, were assessed. Water, benthic and pelagic biota and sediment samples were collected in coastal areas off Barcelona, Spain, near the mouth of the Besos River, near a dumping site, and examined for the tracers. Long-chain alkyl nitriles (LANs) and TAMs were identified for the first time in biota samples at concentrations ranging from 9 to 574  $\text{ng/g}$  and from 157 to 825  $\text{ng/g}$  (fresh weight basis), respectively. In addition, the simultaneous occurrence in the aquatic environment of LANs and TAMs were also reported for the first time. The bioconcentration factor values of both LANs and TAMs varied according to the different species but they were comparable to those found for polycyclic aromatic hydrocarbons. (See also W91-01733) (Agostine-PTT) W91-01723

#### OBSERVATIONS ON OVERWINTERING JUVENILE CHINOOK SALMON (ONCORHYNCHUS Tshawytscha) EXPOSED TO BLEACHED KRAFT MILL EFFLUENT IN THE UPPER FRASER RIVER, BRITISH COLUMBIA.

Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.  
I. H. Rogers, C. D. Levings, W. L. Lockhart, and R. J. Norstrom.  
Chemosphere CSMHAF, Vol. 19, No. 12, p 1853-1868, 1989. 3 fig, 6 tab, 33 ref.

Descriptors: \*Bioaccumulation, \*British Columbia, \*Effluents, \*Fish physiology, \*Industrial wastes, \*Path of pollutants, \*Pulp and paper industry, \*Salmon, Chlorinated hydrocarbons, Ecology, Fish, Freshwater, Rivers, Toxicology.

Chlorophenols and chloroguaiacols were quantified in juvenile chinook salmon captured near bleached kraft mills in the upper Fraser River in December 1987. Fish captured in April 1988 showed up to 55-fold induction of hepatic mixed function oxidase activity (EROD), and were contaminated with up to 370  $\text{ng/kg}$  of 2,3,7,8-trichlorinated dibenzofuran (TCDF) and 68  $\text{ng/kg}$  of 2,3,7,8-trichlorinated dibenzodioxin (TCDD). It is concluded that juvenile chinook salmon that spend

the winter near the pulp mill outfalls in the Upper Fraser River exhibit a strong biochemical response to unidentified inducing compounds in the bleached kraft mill effluent. In addition to 2,3,7,8-TCDD and 2,3,7,8-TCDF, they also accumulate other organic residues. The ecological consequences for these fish are uncertain and further studies are in progress to explore the ensuing stages of the lifecycle until the fish have successfully adapted to salt water. (Agostine-PTT) W91-01724

#### POLYCHLORINATED DIBENZOFURAN (PCDF) AND DIBENZO-P-DIOXIN (PCDD) LEVELS IN ORGANISMS AND SEDIMENTS FROM THE FRIERFJORD, SOUTHERN NORWAY.

Norsk Inst. for Vannforskning, Oslo.  
J. Knutzen, and M. Oehme.  
Chemosphere CSMHAF, Vol. 19, No. 12, p 1897-1909, 1989. 5 fig, 2 tab, 30 ref.

Descriptors: \*Dioxins, \*Fjords, \*Norway, \*Polychlorinated biphenyls, \*Sediment contamination, \*Water pollution sources, Coasts, Crustaceans, Fish, Industrial wastes, Magnesium, Mussels, Pollutant identification, Sediment analysis, Water pollution.

The contamination of a fjord region by dibenzo-p-dioxins (PCDD) polychlorinated dibenzofuran (PCDF) produced from a Mg-production plant has been studied. Levels in organisms (fish, crustacea, mussels) and sediments were determined. The results were used to estimate the spreading of PCDD/PCDF by coastal currents. The present situation is compared with available information from other contaminated areas and with data for other contaminants in the recipient area such as hexachlorobenzene and octachlorostyrene. Compared to data from less contaminated sites, initial results from the sediment studies had 2,3,7,8-TCDD equivalent concentrations that were three orders of magnitude higher. For the characteristic 2,3,7,8-substituted hexachlorodibenzofurans (HxCDFs) of the Mg plant effluent the figures are even higher. The same is valid for PCDD/PCDFs when compared to the content of surface sediments from a lake locality solely contaminated from the atmosphere. Compared to the highest levels reported elsewhere, the Frierfjord sediments contained 50-200 times higher TCDD equivalent levels. (Agostine-PTT) W91-01726

#### ASSOCIATION OF BENZO(A)PYRENE WITH DISSOLVED ORGANIC MATTER: PREDICTION OF KDOM FROM STRUCTURAL AND CHEMICAL PROPERTIES OF THE ORGANIC MATTER.

Oak Ridge National Lab., TN. Environmental Sciences Div.  
J. F. McCarthy, L. E. Roberson, and L. W. Burrus.  
Chemosphere CSMHAF, Vol. 19, No. 12, p 1911-1920, 1989. 1 fig, 2 tab, 28 ref. Department of Energy Contract DE-AC05-84OR21400.

Descriptors: \*Benzopyrene, \*Chemical properties, \*Dissolved solids, \*Organic matter, \*Path of pollutants, \*Structural behavior, Groundwater, Humic acids, Pollutant identification, Statistical analysis, Surface water.

The affinity of dissolved organic matter (DOM) for binding a polycyclic aromatic hydrocarbon, benzo(a)pyrene (BaP), was measured for 11 surface and groundwaters and a commercial humic acid. The hydrophobic acid (HbA) and hydrophobic-neutral (HbN) compositions of the DOM, solution absorptivity at 270 nm (ABS-270), and DOM molar volumes were determined. Waters enriched in HbA material had a larger molar volume and higher aromatic content (as indicated by the ABS-270). There was a good correlation between the size and HbA content of the DOM from the different sources and the Kdom for binding BaP. An excellent predictive relationship was demonstrated between the ABS-270 of a water and the dissolved organic matter partition coefficient (Kdom) for

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binding BaP. Based on these results, it is suggested that binding of a BaP to DOM depends not only on the hydrophobicity of DOM, but also on the existence of an open structure within the DOM to provide access of the aqueous solute to hydrophobic domains within the DOM. (Author's abstract) W91-01727

# ANALYSIS OF TARGET AND NONTARGET POLLUTANTS IN AQUEOUS LEACHATES FROM THE HAZARDOUS WASTE SITE IN STRINGFELLOW, CALIFORNIA, VIA ION CHROMATOGRAPHY-PARTICLE BEAM AND INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY.

California Dept. of Health Services, Berkeley. Hazardous Materials Lab. Section. For primary bibliographic entry see Field 5A. W91-01728

# RATE OF DEGRADATION OF 1,1,1-TRICHLOROETHANE IN WATER BY HYDROLYSIS AND DEHYDROCHLORINATION.

Solvay and Cie S.A., Brussels (Belgium). Central Lab. R. R. Gerkens, and J. A. Franklin. *Chemosphere CMSHAF*, Vol. 19, No. 12, p 1929-1937, 1989. 1 fig, 3 tab, 14 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Dehalogenation, \*Fate of pollutants, \*Hydrolysis, \*Trichloroethane, Degradation, Dehydrochlorination, Kinetics, Oxidation, Rate constants, Sinks.

It is generally assumed that the only significant tropospheric sink for 1,1,1-trichloroethane is gas-phase oxidation initiated by reactions of its C-H bonds with naturally occurring hydroxyl radicals. This assumption is also the basis for calculating globally averaged tropospheric hydroxyl radical concentrations, from the known rate constant for the reaction of hydroxyl radical with 1,1,1-trichloroethane and data on emission rates and tropospheric concentrations of the latter. Degradation of 1,1,1-trichloroethane in water by hydrolysis and dehydrochlorination may conceivably be a significant sink for this compound in the environment. The kinetics of these reactions have been investigated in initially neutral water (becoming acid as the reaction proceeded), over a wide range of temperature (25 to 120 C). The experimental results were consistent with a mechanism in which hydrolysis and dehydrochlorination reactions occur in parallel, according to first-order kinetics with respect to 1,1,1-trichloroethane. It was concluded that: (1) the reaction occurred solely in the aqueous phase; (2) 1,1-dichloroethylene is not an intermediate in the hydrolysis of 1,1,1-trichloroethane to acetic acid. It was found that the activation energies of the hydrolysis and dehydrochlorination reactions are very close. According to the results, hydrolysis is roughly 2.7 times faster than dehydrochlorination at 25 C, i.e. 1,1-dichloroethylene formation represents about 27% of the overall process. The half-lives of 1,1,1-trichloroethane in water at various temperatures, calculated from the rate constants are compared with values reported in the literature. The half-life at 20 C is found to be 1.7 years. (Agostine-PTT) W91-01729

# COMPARATIVE TOXICITY OF SOLVENT YELLOW 33 (2-(2'-QUINOLINYL)-1,3-INDANEDIONE) AND SOLVENT GREEN 3 (1,4-DI-P-TOLUIDINO-ANTHRAQUINONE) DYES TO FRESHWATER ORGANISMS.

Johns Hopkins Univ., Shady Side, MD. Environmental Sciences Group. For primary bibliographic entry see Field 5C. W91-01730

# SIMPLE METHOD FOR ESTIMATING DERMAL ABSORPTION OF CHEMICALS IN WATER.

ENVIRON Corp., Washington, DC. S. L. Brown, and J. E. Rossi. *Chemosphere CMSHAF*, Vol. 19, No. 12, p 1989-2001, 1989. 1 fig, 1 tab, 17 ref.

Descriptors: \*Dermal absorption, \*Path of pollutants, \*Population exposure, \*Public health, \*Toxicology, \*Water pollution, Mathematical studies, Model studies.

A simple method was developed to estimate dermal absorption from variables describing the conditions of exposure and the physical properties of the chemicals in the water. A semiempirical mathematical model is proposed for estimating the dermal absorption of chemicals from dilute aqueous solutions, such as bath water. Absorption depends on the concentration of the chemical in water, the area of skin exposed, the time of exposure, and a permeation coefficient that depends importantly on the relative solubility of the material in lipids and water, among other factors not so easily modeled. Intakes by dermal absorption can be similar to intakes by ingestion from drinking water under certain circumstances for lipophilic chemicals, but they will usually be considerably lower. (Agostine-PTT) W91-01731

# EVALUATION OF THE POTENTIAL FOR TOXIC EXPOSURE IN THE GREAT LAKES REGION USING STORET DATA.

George Mason Univ., Fairfax, VA. Dept. of Biology. L. J. Phillips, and G. F. Birchard. *Chemosphere CMSHAF*, Vol. 20, No. 6, p 587-598, 1990. 1 fig, 5 tab, 12 ref.

Descriptors: \*Data collections, \*Great Lakes, \*Path of pollutants, \*Toxicity, \*Water pollution effects, Databases, Lakes, Mathematical studies, Pollutants, Sediments, Statistical methods.

It has been suggested that residents of the Great Lakes region are at a greater risk of exposure to toxic substances than any other subset of the United States population. This project tested the potential for exposure to toxics by using the levels of toxic substances in fish tissue and sediment as surrogates for human exposure. Data were retrieved from the EPA's STORET database and sorted by USGS water resource regions. STORET is a computerized data base maintained for the storage and retrieval of water quality data within the United States. It is the largest data base available for this purpose, containing data for approximately 150 million individual observations from over 680,000 sampling sites. EPA STORET data for 24 toxics from the 18 USGS regions in the continental United States were retrieved in a statistical summary format. These toxics were chosen because they are National Priority Pollutants for which sufficient STORET data were available. The summaries described the 15th, 50th, 85th percentiles, and minimum, maximum, and mean values for these 24 toxics in sediments and fish tissue for the time periods 1978-1981 and 1982-1987. Data were subjected to two types of statistical analysis. In the first analysis the Great Lakes region was compared to the highest ranked region for each toxic. A second test was designed to provide an index of the potential for exposure by region according to the relative ranks of each toxic. The results indicate that the overall potential for exposure to toxics in the Great Lakes region is not higher than other geographical regions. (Agostine-PTT) W91-01732

# FATE OF CATIONIC SURFACTANTS IN THE MARINE ENVIRONMENT. II: PHOTOOXIDATION OF LONG-CHAIN ALKYLAMINES IN AQUEOUS MEDIA.

Centro de Investigacion y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry. M. Valls, J. M. Bayona, J. Albaiges, and M. Mansour. *Chemosphere CMSHAF*, Vol. 20, No. 6, p 599-607, 1990. 3 fig, 1 tab, 15 ref.

Descriptors: \*Alkylamines, \*Cationic surfactants, \*Environment, \*Fate of pollutants, \*Marine environment, \*Oxidation, \*Surfactants, Mass spectrometry, Nitrogen compounds, Spectroscopy, Water chemistry.

A variety of long-chain alkylamines (NR<sub>1</sub>2R<sub>3</sub>, where R<sub>n</sub> = H, CH<sub>3</sub>, C<sub>14</sub>H<sub>29</sub>, C<sub>16</sub>H<sub>33</sub> or C<sub>18</sub>H<sub>37</sub>) have been photooxidized in pure water and seawater (wavelength > 290 nm). Half-lives of these amines in the two aqueous systems ranged from 25-95 min. and 175-300 min, respectively, depending on the number and molecular weight of the alkyl substituents. According to mass spectral (CGC-MS) and spectroscopic (IR) data, oxidation products in alpha positions with respect to nitrogen have been tentatively identified. Adduct formation between the photosensitizer (acetone) and secondary aliphatic amines is also detected. The stability of photoproducts was dependent of the photooxidation system and in general, they appeared to be more effective than the original amines. (See also W91-01723) (Author's abstract) W91-01733

# POPULATION EXPOSURE TO CHLOROPHENOLS, DIBENZO-P-DIOXINS AND DIBENZOFURANS AFTER A PROLONGED GROUND WATER POLLUTION BY CHLOROPHENOLS.

National Public Health Inst., Kuopio (Finland). Dept. of Environmental Hygiene and Toxicology. P. Lampi, T. Vartiainen, and J. Tuomisto. *Chemosphere CMSHAF*, Vol. 20, No. 6, p 625-634, 1990. 2 fig, 2 tab, 20 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Chlorophenols, \*Groundwater pollution, \*Path of pollutants, \*Population exposure, \*Water pollution effects, Dibenzofurans, Dioxins, Drinking water, Epidemiology, Finland, Risk assessment.

High concentrations of 70 to 140 microgram/L of total chlorophenols were found in the drinking water of about 3,500 inhabitants in southern Finland in 1987. Total chlorophenol levels from 56,000 microgram/L to 190,000 microgram/L were found in the ground water between a sawmill and the water intake plant. In the present study which was carried out 3 months after closure of the water intake plant, an attempt was made to assess the exposure levels of inhabitants in order to provide the basis for epidemiological studies and risk assessment. Based on urinary excretion of chlorophenols it appears that the population using contaminated water, or fish from the contaminated lake, had been exposed to chlorophenols. No increased PCDD/PCDF (polychlorinated dibenzo-p-dioxins/dibenzofurans) concentrations were found in milk samples from mothers who had used the contaminated water. (Author's abstract) W91-01734

# BUTYLINS IN SEDIMENTS AND BIVALVES FROM U.S. COASTAL AREAS.

Texas A and M Univ., College Station. Dept. of Oceanography. T. L. Wade, B. Garcia-Romero, and J. M. Brooks. *Chemosphere CMSHAF*, Vol. 20, No. 6, p 647-662, 1990. 6 fig, 1 tab, 32 ref. NOAA Grant 50-DGNC-5-00262 and Texas A&M University Sea Grant (R/ES-18).

Descriptors: \*Antifoulants, \*Estuaries, \*Mollusks, \*Organotin compounds, \*Path of pollutants, \*Sediment contamination, \*Sediments, Bioavailability, Coasts, Fate of pollutants, Heavy metals.

The concentration of butyltins in sediments from selected U.S. estuarine areas was determined in order to provide information on the role of sediments as long term sinks for butyltin compounds. Butyltin concentrations in sediment samples from U.S. coastal areas ranged from < 5 to 282 ng Sn/g. Butyltins were detected in 75% of the sediment samples analyzed. The predominant butyltin was dibutyltin (TBT), which is also the most toxic. Dibutyltin (DBT) and monobutyltin (MBT) were detected in 30% of the sediment samples analyzed. These TBT degradation products were only found when TBT was present, usually at high concentrations. Mean bivalve butyltin concentrations were 18 times higher than mean sediment concentrations. Based on bivalve analyses, bioavailable butyltins were present at all the sites where butyltins were detected in the sediment. The sediments are

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one possible source of these bioavailable butyltins. However, the lack of correlation between sediments and bivalve butyltin concentration indicates that other sources may be predominant. (Author's abstract)  
W91-01735

**KINETIC STUDY OF THE DECOMPOSITION OF METHYL (1-BUTYL-CARBAMOYL)-1H-BENZIMIDAZOL-2-YL-CARBAMATE (BENOMYL) TO METHYL 1H-BENZIMIDAZOL-2-YL-CARBAMATE (MBC).**  
Brock Univ., St. Catharines (Ontario). Dept. of Chemistry.  
R. P. Singh, I. D. Brindle, C. D. Hall, and M. Chiba.  
Journal of Agricultural and Food Chemistry JAFCAU, Vol. 38, No. 8, p 1758-1762, August 1990. 3 fig, 4 tab, 14 ref.

Descriptors: \*Chemical analysis, \*Degradation, \*Fate of pollutants, \*Fungicides, \*Kinetics, \*Path of pollutants, \*Pesticides, High performance liquid chromatography, Hydrogen ion concentration, Laboratory methods.

The kinetic study of the degradation of benomyl to methyl 1H-benzimidazol-2-ylcarbamate (MBC) in pure water and in aqueous solutions at pH 1-7 has been carried out by using reversed-phase high-performance liquid chromatography (RP-HPLC) at room temperature (21 ± 1°C). The values of first-order rate constants for the degradation reaction were similar in the pH range 2-7, but at high acid concentration (pH 1.0) the rate constant showed a sharp decrease. This may be due to the protonation of benomyl at low pH where a sharp increase in its solubility was also observed. Quantitative conversion of benomyl to MBC was not observed in acetonitrile; instead, due to the reversible nature of the reaction, at equilibrium about 12% benomyl remained intact. The rate constants for the forward reactions in acetonitrile were found to be .00025/s at 21 ± 1°C and .00033/s at 25 ± 1°C. In mixed solutions of water with buffer, acetonitrile, or methanol the degradation of benomyl slowed down with the increase in water concentration. (Author's abstract)  
W91-01739

**FATE OF ADDED N-15 LABELLED NITROGEN IN A SAGITTARIA LANCEPOLIA L. GULF COAST MARSH.**  
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.  
For primary bibliographic entry see Field 2H.  
W91-01741

**PERSISTENT METABOLITES OF ALKYL-PHENOL POLYETHOXYLATES IN THE MARINE ENVIRONMENT.**  
Venice Univ. (Italy). Dept. of Environmental Science.  
A. Marcomini, B. Pavoni, A. Sfriso, and A. A. Orio.  
Marine Chemistry MRCHBD, Vol. 29, No. 4, p 307-323, July 1990. 3 fig, 6 tab, 33 ref.

Descriptors: \*Environment, \*Marine pollution, \*Metabolites, \*Nonionic surfactants, \*Path of pollutants, \*Phenols, \*Surfactants, Algae, Analytical techniques, Sediments, Venice Lagoon, Water.

The persistent metabolites of the nonionic surfactant nonylphenol polyethoxylates (NPnEO, n=1-18), namely nonylphenol (NP), nonylphenol monoethoxylate (NP1EO) and nonylphenol diethoxylate (NP2EO), were analyzed in marine samples including sediment, artificially resuspended sediment and water. The UV-fluorescence high-performance liquid chromatography determination was carried out after Soxhlet extraction with hexane from the sedimentary matrices followed by clean-up on aminosilica minicolumns. Four sampling campaigns at five representative stations of the Venice lagoon were conducted to ascertain temporal and spatial variability of the examined chemicals. A portable resuspending device allowed us to analyze the first 0.01-0.15 mm sediment layer, where the sum of NP, NP1EO and NP2EO was in

the range 0.15-13.7 microgram/g (dry weight basis), at least five times higher than in the underlying 5 cm of sediment. Amounts of resuspended material, and concentrations of NP, NP1EO, NP2EO bound to it, showed a marked seasonal dependence: as much as twice the resuspended material, per unit of sediment surface, was measured in April and July, compared with that in February, but resuspended NP, NP1EO and NP2EO per unit of sediment surface were in February one order of magnitude higher. A major factor responsible for this trend was related to the proliferation of macroalgae which contained an average NP+NP1EO+NP2EO concentration of 0.25 plus or minus 0.15 microgram/g (dry wt.). In water, NPEO oligomers with up to 13 ethoxy units were found at an overall concentration range of 0.6-4.5 microgram/L. (Author's abstract)  
W91-01754

**EFFECTS OF ORGANIC SUBSTRATES ON DECHLORINATION OF AROCLOR 1242 IN ANAEROBIC SEDIMENTS.**  
Michigan Univ., Ann Arbor. Dept. of Civil Engineering.  
L. Nies, and T. M. Vogel.  
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 9, p 2612-2617, September 1990. 1 fig, 3 tab, 14 ref.

Descriptors: \*Acetates, \*Biodegradation, \*Fate of pollutants, \*Glucose, \*Methanol, \*Microbial degradation, \*Polychlorinated biphenyls, \*Soil contamination, Anaerobic conditions, Nutrients, Soil bacteria.

The effects of different organic substrates on the abilities of anaerobic sediment enrichments to reductively dechlorinate polychlorinated biphenyls (PCBs) were studied. Sediments collected from a site previously contaminated with PCBs were dosed with additional PCBs (Aroclor 1242; approximately 300 parts per million (300 micrograms/gram), sediment dry weight) and incubated anaerobically with acetate, acetone, methanol, or glucose. The pattern of dechlorination was similar for each substrate-fed batch; however, the extent and rates of dechlorination were different. Significant dechlorination over time was observed, with the relative rates and extent of dechlorination being greatest for methanol-, glucose-, and acetone-fed batches and least for acetate-fed batches. Dechlorination occurred primarily on the meta- and para-positions of the highly chlorinated congeners, resulting in the accumulation of less-chlorinated, primarily ortho-substituted products. No significant dechlorination was observed in incubation batches receiving no additional organic substrate, even though identical inorganic nutrients were added to all incubation batches. In addition, dechlorination was not observed in autoclaved controls that received substrate and nutrients. (Author's abstract)  
W91-01758

**INTERACTIONS BETWEEN BACILLUS THURINGIENSIS SUBSP. ISRAELENSIS AND FATHEAD MINNOWS, PIMEPHALES PROMELAS RAFINESQUE, UNDER LABORATORY CONDITIONS.**  
Environmental Research Lab.-Duluth, MN.  
V. M. Snarski.  
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 9, p 2618-2622, September 1990. 3 fig, 1 tab, 24 ref.

Descriptors: \*Bacillus, \*Bacteria, \*Biocontrol, \*Minnow, \*Path of pollutants, \*Pesticides, \*Toxicity, \*Water pollution effects, Bacterial growth, Bioaccumulation, Ecological effects, Microbial transport, Spores.

Interactions between *Bacillus thuringiensis* subsp. israelensis and fathead minnows, *Pimephales promelas*, were studied in laboratory exposures to two commercial formulations, Vectocarb-G and Mosquito Attack. Mortality among fatheads exposed to 2,000,000 to 6,500,000 colony forming units/ml with both formulations was attributed to severe dissolved oxygen depletion due to formulation ingredients rather than to direct toxicity from the

parasporal crystal. No adverse effects were observed at 640,000 colony forming units/ml and below. Fathead minnows rapidly accumulated high numbers of spores with 1 hr of exposure to 220,000 colony forming units of Mosquito Attack/ml, producing whole-body counts of 4,000,000 colony forming units/fish. Comparison of counts on gastrointestinal tract samples and whole-body samples and high numbers of spores in feces indicated that ingestion was the major route of exposure. *B. thuringiensis* subsp. israelensis spore counts decreased rapidly after transfer of fish to clean water, with a drop of over 3 orders of magnitude in 1 day. Spores were rarely detected in fish after 8 days but were detectable in feces for over 2 weeks. These findings suggest that fish could influence the dissemination of *B. thuringiensis* subsp. israelensis, and possibly other microbial agents, in the aquatic environment. (Author's abstract)  
W91-01759

**EFFECT OF SULFATE AND ORGANIC CARBON SUPPLEMENTS ON REDUCTIVE DEHALOGENATION OF CHLOROAQUINILINES IN ANAEROBIC AQUIFER SLURRIES.**  
Oklahoma Univ., Norman. Dept. of Botany and Microbiology.  
E. P. Kuhn, G. T. Townsend, and J. M. Sulista.  
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 9, p 2630-2637, September 1990. 6 fig, 1 tab, 37 ref.

Descriptors: \*Biodegradation, \*Chlorinated hydrocarbons, \*Fate of pollutants, \*Groundwater pollution, \*Microbial degradation, \*Organic carbon, \*Pesticides, \*Sulfates, Anaerobic conditions, Dyes, Halogenated hydrocarbons, Metabolism, Sulfur.

When di-, tri-, and tetrachloroaniline were incubated in methanogenic groundwater slurries, they were reductively dehalogenated by the aquifer microbiota. 2,3,4-Trichloroaniline was metabolized by two pathways. Primary dehalogenation occurred at either the meta or ortho position of this substrate to form 2,4- and 3,4-dichloroaniline, respectively. 3,4-Dichloroaniline could be stoichiometrically converted to 3-chloroaniline. 2,3,4,5-Tetrachloroaniline was degraded by the sequential removal of halogens from the para and then the ortho position to form 3,5-dichloroaniline. An additional pathway was observed with this substrate when the aquifer slurries were amended with butyrate. That is, halogens could be removed from both the meta and ortho positions of tetrachloroaniline. The amendment of sulfate to methanogenic aquifer slurries slowed the rate of 2,3,4,5-tetrachloroaniline degradation and increased the amount of substrate channeled through the additional pathway. The reported intermediates or end products were identified by their chromatographic mobility and mass-spectral profiles. (Author's abstract)  
W91-01760

**EFFECTS OF LIGHT, TEMPERATURE, NITRATE, ORTHOPHOSPHATE, AND BACTERIA ON GROWTH OF AND HEPATOTOXIN PRODUCTION BY OSCILLATORIA AGARDHII STRAINS.**  
Helsinki Univ. (Finland). Dept. of Microbiology.  
K. Sivonen.  
Applied and Environmental Microbiology AEMIDF, Vol. 56, No. 9, p 2658-2666, September 1990. 6 fig, 1 tab, 27 ref.

Descriptors: \*Cyanophyta, \*Eutrophication, \*Light intensity, \*Nutrients, \*Temperature effects, \*Toxicity, \*Toxins, Aquatic bacteria, Finland, Lakes, Liquid chromatography, Nitrates, Orthophosphates, Oscillatoria, Path of pollutants.

The effects of bacteria, temperature, light, nitrate, and orthophosphate on growth of and hepatotoxin (desmethyl-3-microcystin-RR) production by *Oscillatoria agardhii* strains were studied under laboratory conditions. Strains were cultivated in Z8 medium under continuous illumination. Growth was determined by measuring dry weight and chlorophyll a, while toxin was analyzed by high-performance liquid chromatography. Two of the three toxic cultures studied produced more toxins

## Sources Of Pollution—Group 5B

in axenic than in nonaxenic cultures. High toxin production was correlated with high nitrogen concentrations (test range, 0.42 to 84 mg/L) and low light intensity (test range, 12 to 95 microeinsteins/sq m/second). Toxin production depended on phosphorus concentration at low levels of phosphorus (0.1 to 0.4 mg/L) and higher concentrations had no additional effect. The optimum temperature for toxin production and growth of green *O. agardhii* was 25°C. Red *O. agardhii* produced almost similar amounts of toxin at temperatures of 15 to 25°C. The lowest toxin production by both strains was at 30°C. (Author's abstract)  
W91-01762

#### DISTRIBUTION AND RATE OF METHANE OXIDATION IN SEDIMENTS OF THE FLORIDA EVERGLADES.

Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.  
For primary bibliographic entry see Field 2H.  
W91-01763

#### RESPONSE OF ATTACHED BACTERIA TO ZINC IN ARTIFICIAL STREAMS.

Indiana Univ.-Purdue Univ. at Fort Wayne. Dept. of Biological Sciences.  
For primary bibliographic entry see Field 5C.  
W91-01772

#### DEGRADATION OF PHENOL BY A BACTERIAL CONSORTIUM UNDER METHANOGENIC CONDITIONS.

Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Microbiologie Appliquée.  
For primary bibliographic entry see Field 5D.  
W91-01773

#### INFLUENCE OF PH ON THE ACCUMULATION OF TRI-N-BUTYL TIN CHLORIDE AND TRIPHENYL TIN CHLORIDE IN CARP.

Shiga Prefectural Inst. of Public Health and Environmental Science, Otsu (Japan).  
T. Tsuda, S. Aoki, M. Kojima, and H. Harada.  
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 95, No. 2, p 151-153, 1990. 2 fig, 2 tab, 13 ref.

Descriptors: \*Antifoulants, \*Bioaccumulation, \*Biological magnification, \*Carp, \*Hydrogen ion concentration, \*Organotin compounds, \*Tributyltin, \*Water pollution effects, Path of pollutants.

Bioconcentration factors (BCF) were examined in carp (*Cyprinus carpio* L.) exposed to organotin compounds at three different pH levels in a continuous flow through system. The order of the BCF in carp at three pH values was pH 7.8 > pH 6.8 > pH 6.0 for both bis(tri-n-butyltin) chloride ( $\text{Bu}_3\text{SnCl}$ ) and triphenyltin chloride ( $\text{Ph}_3\text{SnCl}$ ) over the 14 days exposure period. There were significant differences ( $P < 0.05$ ;  $P < 0.001$ ) in the BCF values of both  $\text{Bu}_3\text{SnCl}$  and  $\text{Ph}_3\text{SnCl}$  between the pH values at 1, 3, 7, 10 and 14 days. Partition coefficients between n-octanol and water (Pow) of both  $\text{Bu}_3\text{SnCl}$  and  $\text{Ph}_3\text{SnCl}$  increased with increasing pH (pH 5.8-8.0). The increase in the BCF values of  $\text{Bu}_3\text{SnCl}$  and  $\text{Ph}_3\text{SnCl}$  with increasing pH is probably due to the change of the chemical forms of tributyltin ion to tributyltin hydroxide and triphenyltin ion to triphenyltin hydroxide. (Author's abstract)  
W91-01774

#### EFFECT OF HEAVY METALS ON THE SEROTONIN AND DOPAMINE SYSTEMS IN THE CENTRAL NERVOUS SYSTEM OF THE FRESHWATER MUSSEL (ANODONTA CYGNEA L.).

Balaton Limnologiai Kutató Intézet, Tihany (Hungary).  
J. Salanki, and L. Hiripi.  
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 95, No. 2, p 301-305, 1990. 4 fig, 17 ref.

Descriptors: \*Bioaccumulation, \*Heavy metals, \*Mussels, \*Nervous system, \*Water pollution ef-

fects, Brain, Cadmium, Copper, Enzymes, Lead, Mercury, Path of pollutants, Zinc.

Heavy metals influencing the filtering behavior of mussels cause alterations in the serotonergic and dopaminergic systems in the central nervous system of *Anodonta cygnea* both in vivo and in vitro. Forty hr exposure of the animals to  $\text{CdCl}_2$  and  $\text{ZnCl}_2$  caused a transient parallel decrease in 5-HT and DA levels of the ganglia. Also  $\text{CuCl}_2$ ,  $\text{HgCl}_2$  and  $\text{PbCl}_2$  lowered 5-HT and DA concentrations during treatment; restoration of 5-HT level was rapid, while that of the DA concentration lasted for several days. In isolated ganglia, uptake of 5-HT and DA was inhibited only at high (.0004 moles/L) heavy metal concentrations; only  $\text{CuCl}_2$  caused 60% depression of DA uptake in .00001 moles/L. Release of monoamines was influenced in a different way: both spontaneous and K-induced 5-HT release were depressed by Zn but were enhanced by Cu, Hg and Pb ions. Spontaneous DA release was enhanced by Cu, while K-induced DA release was increased by Cd, Cu and Zn ions; Hg depressed both. The results give further evidence that heavy metals influence mussels' behavior by influencing the monoamine systems of the brain. The mechanism, however, has not yet been clarified. (Author's abstract)  
W91-01776

#### LABORATORY STUDIES OF THE FLOW OF SOME ORGANIC SOLVENTS AND THEIR AQUEOUS SOLUTIONS THROUGH BENTONITE AND KAOLIN CLAYS.

General Motors Research Labs., Warren, MI. Environmental Science Dept.  
A. S. Abdul, T. L. Gibson, and D. N. Rai.  
Ground Water GRWAAP, Vol. 28, No. 4, p 524-533, July/August 1990. 11 fig, 4 tab, 13 ref.

Descriptors: \*Clays, \*Hydraulic conductivity, \*Linings, \*Organic solvents, Bentonite, Benzenes, Chlorinated hydrocarbons, Flow rates, Kaolinite, Permeameters, Phenols, Toluene.

The following organic solvents and their aqueous solutions were evaluated: benzene, toluene, p-xylene, nitrobenzene, trichloroethylene, ethyl acetate, 2-butanone and phenol. In each experiment, one pore volume of 0.005 N  $\text{CaSO}_4$  water solution flowed through the clays, followed by several pore volumes of aqueous solution of one of the organic solvents, and then by about three pore volumes of the neat organic solvent. The hydraulic conductivity for the aqueous organic solutions was not significantly different from those of water. The flow of the neat solvents through either the bentonite or kaolin clay increased by up to two orders of magnitude. The aqueous solutions did not change the physical appearance of the clays. The more hydrophobic solvents caused the clays to shrink, producing distinct large vertical cracks. The hydrophilic solvents typically caused the clays to aggregate and fracture. The kaolin clay appeared to aggregate more readily than the bentonite clay. The higher swelling of the clays in water than in the neat organic solvents likely caused the physical changes in the clays and the rapid flow of the neat solvents through them. (Author's abstract)  
W91-01781

#### NATURAL BIOREMEDIATION OF ORGANIC CONTAMINANTS IN GROUND WATER: CLIFFS-DOW SUPERFUND SITE.

Dow Chemical Co., Midland, MI. Environmental Sciences Research Lab.  
G. M. Klecka, J. W. Davis, D. R. Gray, and S. S. Madsen.  
Ground Water GRWAAP, Vol. 28, No. 4, p 534-543, July/August 1990. 7 fig, 2 tab, 22 ref.

Descriptors: \*Biodegradation, \*Cliffs-Dow Superfund Site, \*Fate of pollutants, \*Groundwater, \*Groundwater chemistry, \*Groundwater pollution, \*Organic compounds, \*Site remediation, Industrial wastes, Model studies, Phenols, Superfund sites.

Groundwater in the immediate vicinity of an area previously used for the disposal of charcoal manufacturing wastes has been shown to contain low

levels of phenolic and polycyclic compounds. Based on the analysis of samples obtained from monitoring wells, the levels of the organic contaminants are reduced to near or below the detection limit within a distance of 100 meters downgradient of the fill. Examination of the groundwater chemistry indicated that the aquifer is essentially aerobic across the site, except in the immediate vicinity of the fill. At this point, dissolved oxygen is apparently depleted due to the biodegradation of organic contaminants introduced into the groundwater, with a concomitant increase in the inorganic carbon concentration. Laboratory microcosm experiments demonstrated that the naturally occurring microorganisms can readily degrade a mixture of the predominant organic contaminants. Half-lives for biodegradation were in the range of 3 to 8 days for phenolic substrates and 11 to 18 days for naphthalene. Computer model simulations indicated that the attenuation observed in the aquifer cannot be explained in terms of physical processes such as adsorption or dispersion, but is consistent with biological degradation. (Author's abstract)  
W91-01782

#### INDICATORS OF CHEMICAL POLLUTION FROM SEPTIC SYSTEMS.

Geraghty and Miller, Inc., Raleigh, NC.  
For primary bibliographic entry see Field 5A.  
W91-01785

#### USE OF RESISTIVITY SOUNDINGS TO DETERMINE LANDFILL STRUCTURE.

Northern Illinois Univ., De Kalb. Dept. of Geology.  
P. J. Carpenter, R. S. Kaufmann, and B. Price.  
Ground Water GRWAAP, Vol. 28, No. 4, p 569-575 July/August 1990. 5 fig, 2 tab, 33 ref.

Descriptors: \*Geophysical methods, \*Geophysical surveys, \*Groundwater pollution, \*Landfills, \*Leachates, \*Path of pollutants, \*Resistivity, \*Sounding, \*Water pollution sources, Landfill covers, Mapping, Model studies, Waste disposal.

Sixteen Wenner and Schlumberger array electrical soundings were made over portions of the Mallard North landfill in DuPage County, Illinois, to map the gross layered structure of a closed landfill. Sounding curves were fit to standard type curves and values inverted in a least-squares procedure to yield multilayer geoelectrical models. Wood, newspaper, cloth, glass, plastic and metal refuse interspersed with soil exhibited resistivities of 9-19 ohm-m (unsaturated) and 2-7 ohm-m (leachate-saturated). Mature unfactured clay-till cover material exhibited a resistivity of about 30 ohm-m, and its thickness was estimated to within 27% of its true thickness. Larger errors were encountered over fractured and freshly emplaced cover. Soundings were also inverted to yield accurate leachate levels and refuse thickness (errors for both averaged about 30%). Although the soundings produced models with comparable accuracy, the soundings were less sensitive to cover heterogeneities and easier to deploy. Moore's cumulative resistivity interpretation method was found to be unreliable in interpreting this type of resistivity data. However, models generated from electrical resistivity soundings are reasonably accurate in their depictions of internal conditions in this type of landfill. (Author's abstract)  
W91-01786

#### GROUND-SURFACE DELINEATION OF FRACTURES OVER MINED-OUT OPENINGS USING CARBON DIOXIDE EMISSIONS.

Idaho Univ., Moscow. Coll. of Mines and Earth Resources.  
For primary bibliographic entry see Field 5G.  
W91-01787

#### MEASUREMENT AND INTERPRETATION OF LOW LEVELS OF DISSOLVED OXYGEN IN GROUND WATER.

Geological Survey, Menlo Park, CA.  
For primary bibliographic entry see Field 7B.  
W91-01788

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

#### MODELING THE FATE AND TRANSPORT OF ORGANIC CONTAMINANTS IN LAKE ST. CLAIR.

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.  
G. A. Lang, and T. D. Fontaine.  
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 216-232, 1990. 3 tab, 10 fig, 33 ref.  
EPA Interagency Agreement No. DW13931213-01-0.

Descriptors: \*Fate of pollutants, \*Lake St. Clair, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Polychlorinated biphenyls, Cesium, Heavy metals, Lake sediments, Lakes.

In order to understand and predict the transport and fate of organic contaminants in Lake St. Clair, a multisegment, contaminant mass balance model was developed based on the Environmental Protection Agency's TOXIWASP model. The model was calibrated and tested against chloride data and cesium-137 data. It was then used to simulate polychlorinated biphenyl and octachlorostyrene (OCS) dynamics in the lake. The model predicted that during 1971-1983, 3.8 MT of OCS entered the lake, 2.8 MT were flushed from the system, 0.8 MT were lost due to biological degradation and volatilization and 0.2 MT remained in the system. The model also predicted that during 1970-1974, 3.4 MT of PCB entered the lake, 2.1 MT were flushed from the system, 2.2 MT were lost due to biological degradation and volatilization and the system mass of PCB decreased from 1.9 to 1.0 MT. (Author's abstract)  
W91-01792

#### RELATIONSHIP BETWEEN CHLORINATED HYDROCARBONS AND ORGANIC CARBON IN SEDIMENT AND POREWATER.

Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.  
P. D. Capel, and S. J. Eisenreich.  
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 245-257, 1990. 3 tab, 5 fig, 39 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Interstitial water, \*Lake Superior, \*Organic carbon, \*Path of pollutants, \*Polychlorinated biphenyls, \*Sediment-water interfaces, \*Toxic wastes, Distribution patterns, Fate of pollutants, Larvae, Model studies, Sediment analysis.

Chlorinated hydrocarbons and organic carbon were measured in the bulk sediment, very fine, low density, sediment particles, porewater and Hexagenia naiads of Lake Superior sediment to examine the distribution of the hydrophobic organic compounds and how this distribution is influenced by organic carbon. The porewater was divided into filtered and unfiltered fractions. The sediment fractions did not behave the same in their affinity to bind the chlorinated hydrocarbons, nor were all of the chlorinated hydrocarbons bound to the same extent. The affinity for most of the hydrocarbons to the solids were in the order: larvae > fine particles > bulk sediment. The filtered porewater organic carbon (dissolved and/or colloidal) was about 1/3 to 2/3 as efficient as the bulk sediment organic carbon at binding these hydrophobic compounds. A three-phase (solid, porewater organic carbon, dissolved) competitive model estimates that < 10% of the chlorinated hydrocarbons in the porewater are dissolved. The remaining fraction is associated with the organic porewater colloids. (Author's abstract)  
W91-01795

#### INORGANIC CONTAMINANTS IN SUSPENDED SOLIDS FROM HAMILTON HARBOUR.

National Water Research Inst., Burlington (Ontario). Lakes Research Branch.  
T. Mayer, and P. G. Manning.  
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 299-318, 1990. 10 tab, 7 fig, 55 ref.

Descriptors: \*Hamilton Harbour, \*Heavy metals, \*Iron, \*Lake Ontario, \*Phosphorus, \*Pollution load, \*Sediments, \*Water pollution sources, Dredging wastes, Fate of pollutants, Municipal

wastewater, Pollutant identification, Spectral analysis, Spoil banks, Suspended solids.

Concentrations of heavy metals and phosphorus were measured in suspended solids collected from Hamilton Harbour, Lake Ontario, in the spring and late summer of 1986. Forms of iron were determined using Mossbauer spectroscopy and related to the concentrations of heavy metals and phosphorus. Two iron forms, wustite and hematite were identified in addition to naturally occurring Fe(2+) from chlorite and clays and Fe(3+) from amorphous iron oxides. The highest metal concentrations are found in deep water and in areas adjacent to outfalls. The concentrations of wustite and hematite are correlated with the concentrations of heavy metals, particularly Zn and Pb. Heavy metals in suspended solids exceed guidelines for open water disposal of dredged sediments. Phosphorus concentrations in suspended solids are high. Higher than average non-apatite inorganic P concentrations in solids are observed in samples taken from the vicinity of municipal discharges. Manganese and iron were released from bottom sediments during summer anoxia in the hypolimnion of the deep water; however, no phosphorus release was observed. The results indicate that wustite and hematite are good tracers of industrial pollution and their distribution is of importance in determining the particle dynamics in Hamilton Harbour. (Author's abstract)  
W91-01798

#### DISTRIBUTION OF HEAVY METALS IN GOVE HARBOUR, NORTHERN TERRITORY, AUSTRALIA.

Northern Territory Univ., Darwin (Australia). School of Chemistry.  
N. Peerzada, L. McMorrow, S. Skiliros, M. Guinea, and P. Ryan.  
Science of the Total Environment STENDL, Vol. 92, p 1-12, March 1990. 1 fig, 4 tab, 31 ref.

Descriptors: \*Aluminum, \*Cadmium, \*Copper, \*Industrial wastes, \*Iron, \*Lead, \*Manganese, \*Nickel, \*Oysters, \*Path of pollutants, \*Sediment contamination, \*Water pollution, \*Water pollution sources, \*Zinc, Australia, Bauxite treatment plants, Coastal environment, Heavy metals, Sediment analysis, Water analysis.

The concentration of four metals in waters and eight metals in oysters and sediments from Gove Harbour, Northern Territory, were determined during the dry season of 1987. The measured concentrations in the unfiltered waters were: zinc (1.10-7.28), cadmium (0.10-2.20), copper (0.25-3.45), and lead (0.15-2.87) microgram/L. Heavy metal concentrations (in wet weight, micrograms/gram) obtained for oysters from Gove Harbour were as follows: zinc (60.1-970), cadmium (0.14-0.07), copper (3.77-30.67), lead (not detected-0.46), aluminum (6.50-1123.0), nickel (0.02-0.44), manganese (0.24-2.04), and iron (4.28-981.3). In sediments, the following concentrations, in dry weights (in micrograms/gram) were obtained: zinc (0.09-22.24), cadmium (not detected-0.45), copper (not detected-5.96), lead (not detected-2.98), aluminum (229-16053.5), nickel (0.21-7.70), manganese (13.77-50.24), and iron (759.5-2659.6). Concentrations of zinc, aluminum, and cadmium were higher in the oysters. The level of cadmium exceeded the National Health and Medical Research Council (NHMRC) recommended limit. The levels of these and other metals were higher near a bauxite treatment plant. However, no heavy metal data are available at Gove Harbour to establish natural background levels. (Author's abstract)  
W91-01813

#### VOLATILIZATION OF SELENIUM FROM AGRICULTURAL EVAPORATION POND SEDIMENTS.

California Univ., Riverside. Dept. of Soil and Environmental Sciences.  
For primary bibliographic entry see Field 5G.  
W91-01814

#### POLLUTION BY THE FUNGICIDE PENTACHLORONITROBENZENE IN AN INTENSIVE FARMING AREA IN JAPAN.

Environmental Research Center of Kanagawa Prefecture, Yokohama (Japan).

Y. Fushiaki, N. Tase, A. Saeki, and K. Urano.  
Science of the Total Environment STENDL, Vol. 92, p 55-67, March 1990. 10 fig, 3 tab, 15 ref.

Descriptors: \*Agricultural runoff, \*Biodegradation, \*Farming, \*Fate of pollutants, \*Fungicides, \*Path of pollutants, \*Pentachloronitrobenzene, \*Pesticides, \*Water pollution sources, Agricultural chemicals, Japan, Pentachloroaniline, Pentachloroethanol, River sediments, Sediment contamination, Soil contamination.

Environmental pollution by pentachloronitrobenzene (PCNB) was investigated at Tsumagoi, an intensive farming area, where a great amount of PCNB has been applied. High concentrations of PCNB were detected in river water near an area of cabbage cultivation. Further, pentachloroaniline (PCA) and pentachlorothioaniline (PCTA), which are the principal biodegradation products of PCNB, were also detected, and their ratios to PCNB were higher in autumn than in summer. PCNB concentrations in soil were similar to those of river sediments, in which PCNB was concentrated 5,000-10,000 times over levels in river water. The biodegradation rate of PCNB in river water was higher than in river sediment and soil. The formation rates of PCA from PCNB were higher in river sediment and soil than in river water. It is concluded that PCA remains for a long time in the environment and accumulates in river sediment and soil. (Author's abstract)  
W91-01815

#### FATE AND EFFECTS OF PULP MILL CHLOROPHENOLIC 4,5,6-TRICHLOROGUAIACOL IN A MODEL BRACKISH WATER ECOSYSTEM.

Swedish Environmental Research Inst., Karlskrona.  
A. Rosemarin, M. Notini, M. Soderstrom, S. Jensen, and L. Landner.  
Science of the Total Environment STENDL, Vol. 92, p 69-89, March 1990. 7 fig, 6 tab, 23 ref.

Descriptors: \*Algae, \*Bioaccumulation, \*Ecosystems, \*Fucus, \*Littoral environment, \*Model studies, \*Path of pollutants, \*Pulp wastes, \*Water pollution sources, Baltic Sea, Chlorocatechols, Chloroguaiacols, Chlorophenols, Chloroveratroles, Pulp and paper industry, Sweden, Water pollution.

The fate and effects of the pulp mill effluent compound 4,5,6-trichloroguaiacol (TCG) were tested over 16 months on a model Baltic Sea littoral zone using a Fucus vesiculosus-based mesoscale model ecosystem. Bioaccumulation of TCG and metabolites from water ranged from 50 times for algae up to 700 times for invertebrates and fish, the factor increasing with trophic level. Algae contained chloroguaiacols, chlorocatechols and chloroveratroles and exhibited no major toxic effects. Fucus colonization appeared to be hindered by filamentous algae which covered surfaces otherwise available for new colonization. This unrestricted filamentous algal growth was probably the result of reduced grazing by herbivores, which in turn was apparently caused by reproduction failure in herbivorous crustaceans. Sediment-dwelling organisms appeared less affected than invertebrates in an algal habitat, possibly because of reduced bioavailability of toxic compounds due to binding to sediment particles. TCG and metabolites in the sediment were dominated by catechols; no veratroles were found. Only in the largest size class of sticklebacks was there a dose-related reduction in mean weight. Only 0.5% of the TCG added was recovered in the system after 16 months. Of this, 99% was associated with the sediment. The remainder was divided equally between algae and fauna. The role of algae and sediment in the Baltic Sea littoral zone is therefore paramount to the ultimate fate and effects of such compounds on invertebrates and fish. (Author's abstract)  
W91-01816

#### TRENDS IN THE HEAVY METAL LEVELS IN THE DISSOLVED AND PARTICULATE

**PHASE IN THE DUTCH RHINE-MEUSE (MAAS) DELTA.**

Warsaw Univ. (Poland). Dept. of Chemistry.  
J. Golimowski, A. G. A. Merks, and P. Valenta.  
Science of the Total Environment STENDL, Vol. 92, p 113-127, March 1990. 8 fig, 3 tab, 24 ref.

Descriptors: \*Cadmium, \*Chromium, \*Copper, \*Heavy metals, \*Lead, \*Meuse River, \*Rhine River, \*The Netherlands, \*Water pollution sources, \*Zinc, Aquatic environment, Chemical analysis, Chemical properties, Chlorophyll, Distribution coefficients, Nutrients, Seston, Statistical analysis, Waal River, Water analysis.

Levels of the heavy metals Cd, Cr, Cu, Pb, and Zn, in both the dissolved and particulate phase, were determined in two sampling campaigns in August 1978 and August 1984 in the Dutch Rhine-Meuse (Maas) Delta. Besides the heavy metal concentrations, other important parameters were determined, such as the concentrations of seston, chlorophyll and nutrients. The concentrations of dissolved Cd and of Cd, Pb, and Cu in particulate matter were much higher in 1978 than in 1984, especially for Cd. This may be due to the strict regulations implemented in Germany to reduce the pollution of natural waters by heavy metals. The correlation between the high Cd content and the chlorophyll content is explained by the binding of Cd to living and dead organisms. The distribution of the metals between the dissolved and the particulate phase, indicated by the distribution quotient  $K_d$ , increases from low values of  $K_d$  for Cu and Zn, to higher values for Cd and Cr, and the highest values for Pb. The differences are explained by various binding forms of each of these metals in natural waters. (Author's abstract)  
W91-01817

**RAINWATER ACIDITY AT JABIRU, AUSTRALIA, IN THE WET SEASON OF 1983/84.**

Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of Atmospheric Research.  
R. W. Gillett, G. P. Ayers, and B. N. Noller.  
Science of the Total Environment STENDL, Vol. 92, p 129-144, March 1990. 2 fig, 7 tab, 30 ref.

Descriptors: \*Acid rain, \*Air pollution sources, \*Australia, \*Hydrochloric acid, \*Nitric acid, \*Path of pollutants, \*Precipitation, \*Rainfall, \*Sulfuric acid, \*Water pollution sources, Chemical analysis, Data collections, Formic acid, Meteorology, Organic acids, Water analysis.

Rainwater was collected on an event basis at Jabiru, Australia (12 degrees 40 minutes S, 132 degrees 53 minutes E), from 20 October 1983 until 28 March 1984. Analysis showed that rainwater in this area contained only about 20 microequivalents/liter each of major cations and anions. However, the rainfall was acidic (volume weighted mean pH 4.89). The free acidity was due mostly to the presence of formic acid and other unidentified weak organic acids, although sulfuric, nitric, and hydrochloric acids made a significant contributions, especially early in the wet season. A strong meteorological influence on ion concentration was evident in the consistent decrease in concentration associated with the change in storm classification from transitional to monsoonal. Concentrations of sulfur dioxide, aerosol sulfate and cloudwater sulfate due to emissions from the Mount Isa smelting complex 1200 km distant were calculated according to a simple dispersion model used previously in Australian plume studies. The calculations suggest that Mt. Isa would contribute little to atmospheric acidity at Jabiru under the normal range of meteorological conditions in the region. (Author's abstract)  
W91-01818

**SPATIAL AND SEASONAL DIFFERENCES IN THE PCB CONTENT OF THE MUSSEL MYTILUS EDULIS.**

Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).  
H. Hummel, R. H. Bogaards, J. Nieuwenhuize, L. de Wolf, and J. M. van Liere.  
Science of the Total Environment STENDL, Vol.

92, p 155-163, March 1990. 5 fig, 1 tab, 19 ref.

Descriptors: \*Bioaccumulation, \*Estuarine environment, \*Lipids, \*Mytilus, \*Path of pollutants, \*Polychlorinated biphenyls, \*Seasonal variation, \*Spatial distribution, Chemical analysis, Mussels, Oosterschelde Estuary, Salinity, The Netherlands, Westerschelde Estuary.

Seasonal and spatial variation in the concentration of polychlorinated biphenols (PCBs), fats (non-polar lipids) and total lipids and the condition of the mussel *Mytilus edulis* were assessed in three differing water bodies of the Dutch delta area. Highest concentrations of PCBs in the mussel were found in the Westerschelde estuary, with much lower concentrations in the Oosterschelde and the brackish lake Grevelingenmeer. Spatial differences were strongly related to salinity; lower concentrations were found at the more saline stations, pointing to freshwater inputs as being the origin of the PCBs in mussels. The PCB concentration in mussels, on the basis of dry or total weight, in general increased during summer, autumn and winter and decreased strongly during spring. The strong decrease is related to the spawning of gametes. Seasonal changes in the PCB concentrations on the basis of the dry weight were not related to changes in the fat content or the condition of the animals. Only PCBs on a fat basis were negatively related to fat content, indicating a dilution of PCBs during seasonal fat accumulation and concentration of PCBs during fat utilization, in such a way that the total PCB concentration in the animal remains the same. It seems that, besides reproduction, equilibrium partitioning is the most probable mechanism that determines the PCB content of mussels. (Author's abstract)  
W91-01819

**CHEMICAL COMPOSITION OF BULK PRECIPITATION ACROSS THE MOUNTAINS OF SNOWDONIA, U.K.**

Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.  
For primary bibliographic entry see Field 2B.  
W91-01820

**MERCURY, CADMIUM AND LEAD IN EELS AND ROACH: THE EFFECTS OF SIZE, SEASON, AND LOCALITY ON METAL CONCENTRATIONS IN FLESH AND LIVER.**

Essex Univ., Colchester (England). Dept. of Biology.  
N. A. E. Barak, and C. F. Mason.  
Science of the Total Environment STENDL, Vol. 92, p 249-256, March 1990. 1 fig, 4 tab, 17 ref.

Descriptors: \*Absorption, \*Bioaccumulation, \*Cadmium, \*Eel, \*Lead, \*Liver, \*Mercury, \*Muscle, \*Path of pollutants, \*Roach, \*Seasonal variation, Aquatic environment, Brett River, Chelmer River, England, Fate of pollutants, Fish physiology, Heavy metals.

Accumulation patterns of contaminants in fish are dependent both on uptake and elimination rates. The uptake of metals is influenced by many factors, including locality, species, sex, age, and state of gonadal maturation. Elimination of metals is an active biochemical and physiological process. Mercury, cadmium and lead were measured in the liver and flesh of 885 eels and 338 roach collected from four sites on the Rivers Brett and Chelmer, eastern England, over the period November 1985 to November 1987. Concentrations of metals in the liver and flesh of both species were highly correlated at all sites. Generally, mercury in flesh and liver were correlated with fish length in both species. There were fewer significant relationships between length and the concentrations of cadmium and lead. Site differences in mean concentrations were recorded. Seasonal variations in metal concentrations were largely restricted to eels from a more polluted site downstream from the town of Chelmsford. The source of the contamination is unknown. The seasonal effects were mainly detected in livers. This may be related to the differences between organs in relation to the binding strength of metals in body proteins. Weakly bound metals in soft organs, such as the liver, may be more easily

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influenced by seasonal changes compared with strongly bound metals in flesh. (See also W91-01822) (Author's abstract)  
W91-01821

**MERCURY, CADMIUM AND LEAD CONCENTRATIONS IN FIVE SPECIES OF FRESHWATER FISH FROM EASTERN ENGLAND.**

Essex Univ., Colchester (England).  
N. A. E. Barak, and C. F. Mason.  
Science of the Total Environment STENDL, Vol. 92, p 257-263, March 1990. 1 fig, 3 tab, 9 ref.

Descriptors: \*Absorption, \*Bioaccumulation, \*Cadmium, \*Chubs, \*Lead, \*Mercury, \*Path of pollutants, \*Perch, \*Pike, \*Seasonal variation, Aquatic environment, Aquatic life, Biochemistry, Brett River, Chelmer River, Chemical analysis, England, Fate of pollutants, Fish, Heavy metals, Minnow, Tench.

A total of 146 samples of five species of fish were examined between March and November 1986 in four sites from the Rivers Brett and Chelmer in eastern England. Concentrations of mercury, cadmium, and lead were measured in the flesh and liver of 35 dace, 15 chub, 18 tench, 22 perch, and 56 pike. Variations in heavy metals concentrations between the sites and species were found to be related mainly to size differences of fish. Mercury levels in the flesh were higher than in the liver, while cadmium and lead levels were higher in the liver than in the flesh. (See also W91-01821) (Author's abstract)  
W91-01822

**DETERMINATION OF TRACE QUANTITIES OF ORGANOTIN COMPOUNDS IN COASTAL WATERS OF GREECE BY GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY.**

Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.  
For primary bibliographic entry see Field 5A.  
W91-01823

**DEVELOPMENT OF AN EXPERT SYSTEM EMBEDDING PATTERN RECOGNITION TECHNIQUE FOR GROUNDWATER POLLUTION SOURCE IDENTIFICATION.**

California Univ., Davis. Dept. of Civil Engineering.  
B. Datta, J. E. Beegle, M. L. Kavvas, and G. T. Orlob.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-185927/AS. Price codes: A08 in paper copy, A01 in microfiche. Completion Report, 1989. 132p, 33 fig, 16 tab, 38 ref, 9 append. USGS Contract 14-08-0001-G1500.

Descriptors: \*Computer programs, \*Expert systems, \*Groundwater pollution, \*Mathematical models, \*Optimization, \*Sensitivity analysis, Algorithms, Bayes Optimal Decision Rule, Computer models, Model studies, Solute transport models, Statistical studies.

A new methodology for the identification of unknown sources of groundwater pollution is developed. This new methodology is based on the concept of statistical pattern recognition. The statistical pattern recognition algorithm uses Bayes' Optimal Decision Rule. The function of the pattern recognition system is to match statistically an observed set of concentrations in the field with a comparable set obtained by simulating groundwater transport for various disposal conditions. In order to make the application of this methodology easier, an Expert System was developed. This Expert System uses the results obtained by applying the pattern recognition algorithm to select a particular set of pollution source locations and magnitudes. The Expert System also has the capability of adding measures of confidence to alternative selections of sources made by the pattern recognition system, such that these solutions can be ranked according to the subjective confidences supplied by the users. The performance of the

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pattern recognition system and the Expert System was evaluated for a selected study area. (USGS) W91-01825

#### MODELING ORGANIC CONTAMINANT SORPTION IMPACTS ON AQUIFER RESTORATION.

North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering. C. T. Miller, J. A. Pedit, E. G. Staes, and R. H. Gilbertsen.

Available from National Technical Information Service, Springfield, VA 22161 as PB90-185059/AS. Price codes: A06 in paper copy, A01 in microfiche. North Carolina Water Resources Research Institute, Raleigh, Completion Report No. 246, (UNC-WRRI-89-246), July 1989. 92p, 20 fig, 6 tab, 79 ref, 3 append. State Project 70078.

Descriptors: \*Aquifers, \*Groundwater pollution, \*Model studies, \*Organic wastes, \*Sorption, Mathematical models, North Carolina, Oil wastes, Path of pollutants, Sorption equilibrium models, Water pollution sources.

The groundwater resources of the U.S. have been contaminated by a variety of organic pollutants that include solvents, petroleum products, and pesticides. A need exists to understand the movement of contaminants in the subsurface so that: (1) an assessment of the risk due to contamination may be made; (2) an economical and environmentally acceptable response to contamination may be designed; and (3) an appropriate ranking of sites that require clean-up and that are competing for the same fixed pool of resources may be accomplished. Many common organic contaminants sorb to solid surfaces, like soils or aquifer materials. Sorption affects the rate of transport for a given contaminant in the subsurface and may also affect the rate of contaminant degradation. An understanding of the sorption process is, therefore, an important part of understanding the overall movement of a contaminant in the subsurface. This work focuses on the investigation of the sorption process in the subsurface. Specifically four aspects are considered: the measurement of sorption equilibrium for petroleum-based contaminants to a coastal North Carolina aquifer material; determination of the rate of sorption for these systems; development of mathematical models that may be used to simulate the sorption process; and an analysis of the significance of sorption-desorption rates for predicting field-scale transport of organic contaminants. Laboratory results demonstrate the relative importance of sorption as a function of compound type using aquifer material collected from a Camp Lejeune field site. The sorption process is shown to require several days to approach equilibrium, while the final equilibrium is found to be nonlinear. (USGS) W91-01827

#### TRITIUM CONCENTRATIONS IN FLOW FROM SELECTED SPRINGS THAT DISCHARGE TO THE SNAKE RIVER, TWIN FALLS-HAGERMAN AREA, IDAHO.

Geological Survey, Idaho Falls, ID. Water Resources Div. L. J. Mann.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4156, 1989. 20p, 2 fig, 3 tab, 15 ref.

Descriptors: \*Path of pollutants, \*Radioactive wastes, \*Radioactivity, \*Springs, \*Tritium, Idaho, Idaho National Engineering Laboratory.

Concern has been expressed that some of the approximately 30,900 curies of tritium disposed to the Snake River Plain aquifer from 1952 to 1988 at the INEL (Idaho National Engineering Laboratory) have migrated to springs discharging to the Snake River in the Twin Falls-Hagerman area. To document tritium concentrations in springflow, 17 springs were sampled in November 1988 and 19 springs were sampled in March 1989. Tritium concentrations were less than the minimum detectable concentration of 0.5 pCi/mL (picocuries/mL) in November 1988 and less than the minimum detectable concentration of 0.2 pCi/mL in March 1989;

the minimum detectable concentration was smaller in March 1989 owing to a longer counting time in the liquid scintillation system. The maximum contaminant level of tritium in drinking water as established by the U.S. Environmental Protection Agency is 20 pCi/mL. U.S. Environmental Protection Agency sample analyses indicate that the tritium concentration has decreased in the Snake River near Buhl since the 1970's. In 1974-79, tritium concentrations were less than 0.3 +/- 0.2 pCi/mL in 3 of 20 samples; in 1983-88, 17 of 23 samples contained less than 0.3 +/- 0.2 pCi/mL of tritium; the minimum detectable concentration is 0.2 pCi/mL. On the basis of decreasing tritium concentrations in the Snake River, their correlation to cessation of atmospheric weapons tests tritium concentrations in springflow less than the minimum detectable concentration, and the distribution of tritium in groundwater at the INEL, aqueous disposal of tritium at the INEL has had no measurable effect on tritium concentrations in springflow from the Snake River Plain aquifer and in the Snake River near Buhl. (USGS) W91-01833

#### INORGANIC AND ORGANIC GROUNDWATER CHEMISTRY IN THE CANAL CREEK AREA OF ABERDEEN PROVING GROUND, MARYLAND.

Geological Survey, Towson, MD. Water Resources Div.

M. M. Lora, and D. A. Vroblecky.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4022, 1989. 97p, 3 pl, 11 fig, 16 tab, 49 ref.

Descriptors: \*Aromatic compounds, \*Chlorinated hydrocarbons, \*Fate of pollutants, \*Groundwater pollution, \*Maryland, \*Path of pollutants, \*Water quality, Aberdeen Proving Ground, Aliphatic hydrocarbons, Chemical degradation, Coastal aquifers, Inorganic compounds, Microbial degradation, Organic solvents, Physicochemical properties, Unconsolidated aquifers.

Groundwater chemical data were collected from November 1986 through April 1987 in the first phase of a 5-year study to assess the possibility of groundwater contamination in the Canal Creek area of Aberdeen Proving Ground, Maryland. Water samples were collected from 87 observation wells screened in Coastal Plain sediments; 59 samples were collected from the Canal Creek aquifer, 18 from the overlying surficial aquifer, and 10 from the lower confined aquifer. Dissolved solids, chloride, iron, manganese, fluoride, mercury, and chromium are present in concentrations that exceed the Federal maximum contaminant levels for drinking water. Elevated chloride and dissolved-solids concentrations appear to be related from contaminant plumes but also could result from brackish-water intrusion. Excessive concentrations of iron and manganese were the most extensive water quality problems found among the inorganic constituents and are derived from natural dissolution of minerals and oxide coatings in the aquifer sediments. Volatile organic compounds are present in the Canal Creek and surficial aquifers, but samples from the lower confined aquifer do not show any evidence of contamination by inorganic or organic chemicals. The volatile organic contaminants detected in the groundwater and their maximum concentrations (in micrograms/L) include 1,1,2,2-tetrachloroethane (9,000); carbon tetrachloride (480); chloroform (460); 1,1,2-trichloroethane (80); 1,2-dichloroethane (990); 1,1-dichloroethane (3.1); tetrachloroethylene (100); trichloroethylene (1,800); 1,2-trans-dichloroethylene (1,200); 1,1-dichloroethylene (4.4); vinyl chloride (140); benzene (70); and chlorobenzene (39). On the basis of information on past activities in the study area, some sources of the volatile organic compounds include: (1) decontaminants and degreasers; (2) clothing-impregnating operations; (3) the manufacture of impregnate material; (4) the manufacture of tear gas; and (5) fuels used in garages and at the air-field. The high density of most of the detected organic compounds in free-product form would have aided their movement into the aquifers by vertical sinking. The outcrop area of the upper confining unit and an area cut by a paleochannel are most susceptible to

contamination because a near-surface impermeable layer is not present. (USGS) W91-01837

#### HYDROGEOLOGIC, WATER-LEVEL, AND WATER-QUALITY DATA FROM MONITORING WELLS AT THE U.S. MARINE CORPS AIR STATION, CHERRY POINT, NORTH CAROLINA.

Geological Survey, Raleigh, NC. Water Resources Div.

L. C. Murray, and K. M. Keoughan.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4200, 1990. 86p, 14 fig, 9 tab, 26 ref.

Descriptors: \*Cherry Point, \*Groundwater pollution, \*Hydrologic data, \*Monitoring, \*North Carolina, \*Observation wells, \*Water quality, \*Water resources data, Hydrogeology, Pollutant identification, Sedimentary petrology.

Unlined hazardous-waste disposal sites at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, are located near drinking water supply wells that tap the Castle Hayne aquifer. Hydrogeologic and water quality data were collected near two of these sites from 12 monitoring wells installed in May to June 1987. Near the northernmost disposal site, differences in hydraulic head between the surficial, intermediate Yorktown, and Castle Hayne aquifers indicate the potential for migration of contaminants downward into the Castle Hayne. Movement would be impeded, however, by two confining units that separate the three aquifers. Near the southernmost landfill, these units are thin and discontinuous. However, water-level data in this area indicate that water from both the Castle Hayne and Yorktown aquifers flows upward into the surficial aquifer, which reduces the potential for downward contaminant movement. Groundwater in the surficial aquifer at both sites moves laterally away from nearby drinking water supply wells and toward Sloum Creek. Elevated concentrations of trichloroethylene and 1,2-dichloroethane (4,600 and 4,800 ug/L (micrograms per liter), respectively) were detected in water samples collected from the surficial aquifer near the southernmost landfill; smaller concentrations were detected in the Yorktown aquifer (16 and 8 ug/L, respectively). With the exception of iron and manganese, trace metals detected in the wells sampled near both landfills were below U.S. Environmental Protection Agency drinking water standards. Highest concentrations of priority pollutant metals detected were for zinc (60 ug/L) and chromium (36 ug/L). (USGS) W91-01844

#### SOURCES AND DISTRIBUTION OF NITRATE IN GROUND WATER AT A FARMED FIELD IRRIGATED WITH SEWAGE TREATMENT PLANT EFFLUENT, TALLAHASSEE, FLORIDA.

Geological Survey, Tallahassee, FL. Water Resources Div.

For primary bibliographic entry see Field 5E. W91-01857

#### COMPARING THE EFFECTS OF ACIDIC DEPOSITION ON THE CHEMISTRY OF SMALL STREAMS IN THE SOUTH ISLAND OF NEW ZEALAND WITH THOSE IN THE FICHELGEIRGE, F.R.G.

Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer Hydrologie.

A. Stenzel, and R. Herrmann.

Catena, Vol. 17, No. 1, p 69-83, February 1990. 2 fig, 6 tab, 22 ref.

Descriptors: \*Acid rain effects, \*Acid streams, \*Acidic water, \*Aluminum, \*New Zealand, \*Organic acids, \*Water chemistry, \*Water pollution sources, \*West Germany, Conductivity, Deposition, Fluorides, Phosphates, Sediment load, Statistical analysis, Streams, Sulfates, Water sampling.

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There are some major differences in the chemical composition of unpolluted clear and brownwater (natural acid) streams in New Zealand and the polluted White Main in Bavaria, West Germany. Sulfate concentrations are 10 to 20 times higher in the White Main and atmospheric inputs of strong acids ( $H_2SO_4$  and  $HNO_3$ ) cause pH values of 5.0 and lower. Clearwaters in New Zealand show neutral pH values of between 6.6 and 8.0 whereas brownwaters have a pH of 4.0, but their acidity is derived from organic acids. Concentrations of aluminum are low in the New Zealand clearwaters and consist mainly of polymeric species. Brownwaters show relatively high aluminum concentrations, dominated by monomeric aluminum species, but these are complexed with organic acids. In contrast to this, the White Main has high concentrations of the toxic monomeric inorganic form. Inputs of strong mineral acids on natural acid streams may induce a change in the aluminum chemistry and turn the organic nontoxic aluminum species into toxic forms. There is not a significant difference in major cation concentrations between the White Main and New Zealand streams. Variation in the New Zealand water samples is caused by location differences, for example, coastal streams have higher concentrations of sea salt cations than inland waters. (Author's abstract)

W91-01870

#### TRAVEL TIMES OF SEEPAGE WATER THROUGH MULTILAYERED COVERING SYSTEMS FOR HAZARDOUS WASTE SITES.

Karlsruhe Univ. (Germany, F.R.). Dept. of Applied Geology.  
S. Wöhnlich.

Environmental Geology and Water Sciences  
EGWSEI6, Vol. 15, No. 2, p 137-144, March/  
April 1990. 7 fig, 6 ref.

Descriptors: \*Barriers, \*Flow velocity, \*Hazardous materials, \*Infiltration, \*Landfill covers, \*Lysimeters, \*Path of pollutants, \*Seep water, \*Seepage, \*Traveltime, \*Waste disposal, Drainage, Field tests, Hydraulic design, Porosity, Soil water, Surface runoff, Tracers.

In a field experiment station near Frankfurt am Main, West Germany, a three-layer covering system was constructed in order to evaluate the amount of seepage water through clay barrier systems and their long-term effectiveness. The test area was equipped with two large-scale lysimeters, excess tubes (for neutron-moisture and gamma-gamma-density measurements), tensiometers, surface runoff and drain discharge recorders and other meteorological instruments. The results of the three-year observation period gave a complete record of the infiltration and seepage process within the different covering layers. With the help of hydrochemical and isotope analyses, as well as with tracer experiments, the velocity of the soil water was determined. Three major waterpaths were found in the vadose zone of the vegetation support layers as well as in the saturated zone of the barrier layer. Very low velocities followed the matrix porosity of the soil. High velocities occur along preferential waterpaths which follow inhomogeneities within the soil. Minor parts of the lysimeter outflow react directly with the precipitation inflow and, therefore, reveal that unretarded flowpaths exist as well. The higher the compaction of the clay, the more dominant is the influence of preferential flow paths. The travel times through the clay barriers are much faster than currently thought. A breakthrough in contaminants occurs much earlier than estimated by assuming homogeneous flow. It is recommended that large scale field tests using simple flexible lysimeters be used to determine the effective flux density at each individual site. (Stoehr-PTT)

W91-01886

#### CHEMICAL THREAT TO THE ENVIRONMENT IN POLAND.

Lublin Technical Univ. (Poland). Dept. of Water and Wastewater Technology.  
L. Pawlowski.

Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 1-21, July 1990. 1 fig, 14 tab, 7 ref.

Descriptors: \*Acid rain, \*Air pollution, \*Environmental quality, \*Heavy metals, \*Poland, \*Political aspects, \*Pollution load, \*Soil contamination, \*Water pollution sources, Acidic soils, Carcinogens, Economic aspects, Environmental effects, Environmental policy, Foods, Human diseases, Nitrous oxide, Sulfur dioxide, Trace elements, Vistula River.

Pollution of the environment in Poland is characterized and the concentrations of  $SO_2$ ,  $NO_x$ , dust and metals in the air are tabulated. Surface water is classified according to sanitary standards, and the concentrations of heavy metals in the River Vistula are presented. Soil is mainly polluted with trace elements such as mercury, lead, cadmium, zinc, copper and fluorine. Eighty-three percent of the cultivated soils in Poland are acidic due to the interaction of sulfur and its compounds deposited on the ground with other atmospheric contaminants. The causes and sources of food contamination include fertilizers, pharmaceutical preparations given to animals, and food processing and packaging. The characteristics of the Polish economy which may influence the nation's pollution problems include the nation's high energy consumption and the inability to manufacture suitable equipment for environmental restoration. In addition, purchasing equipment from abroad is limited due to Poland's shortage of hard currency. Significant changes should not be expected in the next few years without international assistance. There are unsolved problems concerning the influx of  $SO_2$  and other pollutants from other countries. Poland also exports air pollutants to other countries. For environmental quality to improve, all the surrounding countries have to agree on implementing beneficial environmental policies. (Stoehr-PTT)

W91-01887

#### ACID PRECIPITATION MONITORING AND RESEARCH. REVIEW OF CURRENT NORWEGIAN ACTIVITIES.

Oslo Univ. (Norway). Dept. of Chemistry.  
For primary bibliographic entry see Field 5G.  
W91-01888

#### OCCURRENCE OF HEAVY METALS IN WATER, PHYTOPLANKTON, AND ZOOPLANKTON OF A MESOTROPHIC LAKE IN EASTERN POLAND.

Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.  
S. Radwan, W. Kowalik, and C. Kowalczyk.  
Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 115-120, July 1990. 2 fig, 1 tab, 17 ref.

Descriptors: \*Bioaccumulation, \*Heavy metals, \*Lakes, \*Mesotrophic lakes, \*Path of pollutants, \*Phytoplankton, \*Poland, \*Zooplankton, Cadmium, Cobalt, Copper, Iron, Lake Piaseczno, Lead, Manganese, Pollutant identification, Water pollution, Zinc.

The concentrations of the heavy metals copper, zinc, manganese, iron, cadmium, lead, and cobalt were determined in phytoplankton, zooplankton and water of the mesotrophic Lake Piaseczno. The zooplankton community consists of three basic groups, Rotaria, Cladocera and Copepoda, which were caught in light traps. Net phytoplankton is represented mainly by Chlorophyta and Conjugata. The concentrations of heavy metals differed in phytoplankton and zooplankton, especially with respect to Mn, Pb, Cu and Cd. For both communities the highest metal concentrations were exhibited by iron, zinc and manganese. These levels were many times higher than the levels in water. Manganese was at a higher concentration in the phytoplankton than in the zooplankton, and lead, copper and cadmium were at higher concentrations in the zooplankton than in the phytoplankton. High bioaccumulation indices for both plankton communities were found for iron, manganese and zinc, and very low indices were found for lead and cadmium. This may be evidence of the rate and selective uptake of particular trace metals by the phytoplankton and zooplankton. If the bioaccumulation index for one trace metal is higher than that

of a second trace metal, then the former is absorbed more rapidly from water by a given plankton community. (Stoehr-PTT)

W91-01891

#### ACCUMULATION OF HEAVY METALS IN A LAKE ECOSYSTEM.

Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.  
S. Radwan, W. Kowalik, and R. Kornijow.  
Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 121-129, July 1990. 1 tab, 27 ref.

Descriptors: \*Bioaccumulation, \*Heavy metals, \*Lakes, \*Mesotrophic lakes, \*Path of pollutants, \*Plankton, Benthos, Fish, Lake Piaseczno, Phytoplankton, Poland, Sediment contamination, Water pollution, Zooplankton.

The concentrations of copper, zinc, iron, manganese, cadmium, nickel, lead, and cobalt were determined in water, bottom sediments, plankton, zoobenthos and ichthyofauna of mesotrophic Lake Piaseczno located in eastern Poland. In water, sediments, plankton and benthos, the most abundant heavy metals were iron, zinc and manganese. In fish zinc, copper and manganese were most abundant. The amount of heavy metals in the biotic components was dependent upon their concentration in water and partly upon the concentration in bottom sediments. A considerably less important role in the translocation of heavy metals is probably played by trophic interactions. (Author's abstract)

W91-01892

#### ASSESSMENT OF ALUMINUM MOBILIZATION AND PATHWAYS IN THE BIRKENES CATCHMENT, SOUTHERN NORWAY.

Oslo Univ. (Norway). Dept. of Chemistry.  
R. Vogt, H. M. Seip, N. Christophersen, and S. Andersen.  
Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 139-158, July 1990. 6 fig, 3 tab, 39 ref.

Descriptors: \*Acid rain effects, \*Acid streams, \*Aluminum, \*Model studies, \*Norway, \*Path of pollutants, \*Temporal distribution, Lysimeters, Mathematical models, Soil water, Streams, Sulfur compounds, Tracers, Water pollution.

In spite of considerable research efforts the detailed mechanisms involved in acidification, and in particular those controlling aluminum concentrations in water, have not been satisfactorily established. Earlier work on acidification carried out in the Birkenes catchment in southern Norway is briefly reviewed. Temporal variation in acidity and aluminum concentrations in stream water are related to variations in ionic loadings. Addition of sodium bromide to two small soil plots in Birkenes resulted in high concentrations of hydrogen in the organic horizon and of aluminum in the eluvial horizon. The experiment supports the hypothesis presented earlier that water pathways are of great significance in determining stream water chemistry. The improvement of existing models for calculating stream water aluminum concentrations may require the use of at least three soil reservoirs in a model to reproduce observed aluminum satisfactorily. (Author's abstract)

W91-01893

#### ARE MATHEMATICAL MODELS USEFUL FOR UNDERSTANDING WATER ACIDIFICATION.

Oslo Univ. (Norway). Dept. of Chemistry.  
A. Stone, and H. M. Seip.  
Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 159-174, July 1990. 5 fig, 1 tab, 18 ref, append.

Descriptors: \*Acid rain, \*Acidic water, \*Mathematical models, \*Model studies, \*Simulation, Chemical analysis, Computer models.

Computer models play an integral part in the effort to understand the complicated processes which

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affect ecosystems subjected to acid precipitation. Current research work using the Birkenes (Norway) model attempts to improve the evaluation of the present model structure and subjects the program to a stringent verification process. Simulation results for years which are not included in the calibration period are described. Checking model parameters against data sets not used in the calibration process is essential. The importance of model validation is emphasized. The simulations, though in agreement with the observations, are still deficient in some respects and possible model improvements are necessary. In addition, problems which appeared during model validation were also found during verification procedures. However, computer simulations have provided a powerful tool for evaluating current thinking regarding chemical processes involved in environmental problems such as acid precipitation. (Author's abstract)  
W91-01894

**ALUMINUM MOBILIZATION IN SOIL AND STREAM WATERS AT THREE NORWEGIAN CATCHMENTS WITH DIFFERENT ACID DEPOSITION AND SITE CHARACTERISTICS.**  
Senter for Industriforskning, Oslo (Norway).  
N. Christoffersen, C. Neal, R. Vogt, J. M. Esser, and S. Andersen.  
Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 175-188, July 1990. 5 fig, 5 tab, 24 ref.

Descriptors: \*Acid rain effects, \*Aluminum, \*Deposition, \*Norway, \*Soil chemistry, \*Soil water, \*Water pollution effects, Cation exchange, Hydrogen ion concentration, Ion exchange, Model studies.

Streamwater, soil water, and soil chemistry data were collected for three Norwegian headwater catchments and comparisons made to allow assessment of the effects of acid deposition on aluminum mobilization. Two of the sites, situated in the most heavily impacted area of southern Norway, show pronounced differences in streamwater chemistry, especially at highflow. At Birkenes I, the pH reaches 4.2 and the inorganic monomeric aluminum reaches 20 µM, compared with a pH of 5.4-6 and aluminum at 3 µM at Birkenes II. The third catchment (Ingabekken) is in a pristine area in mid-Norway where streamwater pH changes from 7.2 at baseflow to 5 at highflow. In this case, aluminum is less than 1 µM. The differences in streamwater chemistry are mirrored in the soil solution composition at the three sites. Major differences also occur in the compositions of exchangeable ions, even though cation exchange capacities are similar. In the pristine area, exchangeable aluminum is low, with the exchange complex being dominated by hydrogen. This contrasts with the impacted sites where exchangeable aluminum is much more abundant, especially at Birkenes I. It is concluded that one of the main changes observed during acidification is the conversion of the soil exchange complex from a hydrogen-dominated form to one where aluminum plays an increasingly important role. Such a transformation is not included in most acidification models and should be the focus of further model development. (Author's abstract)  
W91-01895

**INTERPRETATION OF METAL CONCENTRATIONS IN ESTUARINE SEDIMENTS OF FLORIDA USING ALUMINUM AS A REFERENCE ELEMENT.**  
Florida State Dept. of Environmental Regulation, Tallahassee.  
For primary bibliographic entry see Field 2L.  
W91-01898

**ATMOSPHERIC INPUT OF INORGANIC NITROGEN SPECIES TO THE KIEL BIGHT.**  
Kiel Univ. (Germany, F.R.). Inst. fuer Meereskunde.  
R. Prado-Fiedler.  
Helgolander Meeresuntersuchungen HEMEDC, Vol. 44, No. 1, p 21-30, August 1990. 4 fig, 4 tab, 22 ref. Umweltbundesamt (UBA) grant no.

10204215/4.

Descriptors: \*Air pollution, \*Chemistry of precipitation, \*Kiel Bight, \*Nitrogen, \*Nitrogen compounds, \*Nutrients, \*Path of pollutants, \*Water pollution sources, Deposition, Phytoplankton, Precipitation.

The atmospheric input of inorganic nitrogen species to the Kiel Bight (south-west Baltic Sea) was measured by collecting marine precipitation samples at Kiel Lighthouse in weekly intervals during a whole year, using wet-only and bulk-sample methods. The temporal patterns of nitrate and ammonium concentrations are highly variable, with less variability during summer. Maximum concentrations were found in winter. The annual precipitation weighted mean concentrations are 124 micromoles/cu dm for nitrate and 172 micromoles/cu dm for ammonium. Nitrite concentrations were low, its contribution to wet deposition being thus negligible (on average only 0.3% of the wet deposition of nitrate plus ammonium). Dry deposition represents approximately one third of the total input of airborne nitrogen species. Wet and dry deposition represents an annual input of around 5000 tons of nitrogen to the Kiel Bight (2571 sq km) which is a significant contribution to the total nitrogen content (5900 tons in winter). Rain does not fall uniformly along a front system and marine rains are usually associated with showers having a typical horizontal cross section of 500 m to 5 km, the intense episodic input of nitrogen species concentrated in a relatively small area may contribute to the formation of a patch of phytoplankton. Hence, the origin of phytoplankton patchiness may be related to the characteristic pattern of precipitation. (Author's abstract)  
W91-01921

**URANIUM AND THORIUM IN MUSCLE TISSUE OF FISH TAKEN FROM THE SOUTHERN BALTIC.**  
Akademia Medyczna, Gdansk (Poland). Dept. of Analytical Chemistry.  
P. Szefer, K. Szefer, and J. Falandysz.  
Helgolander Meeresuntersuchungen HEMEDC, Vol. 44, No. 1, p 31-38, August 1990. 1 fig, 4 tab, 43 ref.

Descriptors: \*Baltic Sea, \*Bioaccumulation, \*Biological magnification, \*Fish physiology, \*Thorium, \*Uranium, Cod, Food chains, Herring, Mollusks, Sprat, Tissue analysis.

The determination of uranium (U) and thorium (Th) was carried out on pooled muscle tissue samples of cod (*Gadus morhua*), herring (*Clupea harengus*), sprat (*Sprattus sprattus*) and other species of fish caught in 1981 in the southern Baltic. The mean levels of U in the muscle tissue were 0.30 ng/g for cod (*Gadus morhua*), 0.29 ng/g for herring (*Clupea harengus*) and 0.44 ng/g for sprat (*Sprattus sprattus*) on a wet-weight basis. For Th the concentrations were 0.41 ng/g for cod, 0.38 ng/g for herring, and 0.64 ng/g for sprat. For the other species analyzed, the muscle levels of U varied from 0.22-0.42 w.w. and of Th from 0.43-1.6 ng/g w.w. Elevated levels of U were also found in whole specimens of stickleback (*Gasterosteus aculeatus*) (2.6ng/g w.w.). The muscle-levels of U were comparable to the lowest values reported by other authors for Japanese and Black Sea Fish. The ratio of Th/U (by weight) for *Gadus morhua*, *Clupea harengus* and *Sprattus sprattus* was near unity. The average southern Baltic water data for U and Th in fish and other Baltic organisms were used to calculate the concentration factor (CF). The values of CF-U and CF-Th for fish as well as for other representatives of Baltic biocenosis reveal that the soft tissue of mollusks had high concentrations of U and whole specimens of Mesidothea entomon had high concentrations of Th. However, in fish the smallest amounts of the two elements were concentrated. To determine the degree of discrimination of U in respect to Th in Baltic organisms, the discrimination factor DF was estimated and results showed that analyzed organisms exhibit a stronger ability to adsorb and/or take up Th as compared to U. The U and Th transfer along the trophic levels of the food chain was quantitatively estimated by the transfer factor TF. TF

values suggested that there is no biomagnification of these elements along the food chain steps leading to fish from their potential diet. (Fleishman-PTT)  
W91-01922

**NOAA'S STATUS AND TRENDS MUSSEL WATCH PROGRAM: CHLORINATED PESTICIDES AND PCBs IN OYSTERS (CRASSOSTREA VIRGINICA) AND SEDIMENTS FROM THE GULF OF MEXICO.**  
Texas A and M Univ., College Station. Dept. of Oceanography.  
For primary bibliographic entry see Field 5A.  
W91-01933

**DENITRIFICATION AND NITROUS OXIDE IN THE NORTH SEA.**  
Plymouth Marine Lab. (England).  
C. S. Law, and N. J. P. Owens.  
Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 1/2, p 65-74, May 1990. 7 fig, 1 tab, 26 ref.

Descriptors: \*Coastal waters, \*Denitrification, \*Fate of pollutants, \*Nitrogen, \*Nitrogen oxides, \*North Sea, \*Sediment chemistry, German Bight, Nitrates, Nitrification, Norwegian Trench.

In situ sediment denitrification rates were determined in the major areas of deposition of the North Sea, using the acetylene block technique. In addition, nitrous oxide profiles of the water column were determined. Nitrous oxide production generally occurred in the photic zone possibly due to nitrification; and throughout the water column in the German Bight region. Consumption at depth was possibly due to reduction in the anoxic microzones of fecal pellets, concentrated at the thermocline. Saturation of surface waters was 102.2% compared to 130.3% in the German Bight region. Calculated flux of nitrous oxide to the atmosphere was 9.5 times 10 to the 6th power kg per year, over half of which was produced in the German Bight. Sediment denitrification rates varied through three orders of magnitude; the highest value of 150 micromoles per meter squared per day was recorded in the Norwegian Trench. Nitrous oxide production by the sediments was low (1.1 micromoles per meters squared per day max.), and was undetectable at half of the sites. Sediment nutrient profiles exhibited porewater nitrate concentrations exceeding that of the overlying water suggesting that denitrification was fuelled by nitrification, which, in turn was related to other environmental variables. A significant positive relationship existed between in situ denitrification rate and the nitrate content of the upper sediment. Extrapolation of the rate to the total area of deposition in the North Sea suggests that denitrification is responsible for a minimum loss of 7.5-12% of the total annual nitrogen contaminant input. (Author's abstract)  
W91-01935

**CONCENTRATIONS OF ORGANOCHLORINE COMPOUNDS IN THE HERMIT CRAB PAGURUS BERNHARDUS FROM THE GERMAN BIGHT, DECEMBER 1988 - MAY 1989.**  
Hamburg Univ. (Germany, F.R.). Inst. fuer Biochemie und Lebensmittelchemie.  
R. Knickmeyer, and H. Steinhart.  
Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 3, p 365-376, June 1990. 16 fig, 2 tab, 39 ref.

Descriptors: \*Bioaccumulation, \*Chlorinated hydrocarbons, \*Crabs, \*German Bight, \*North Sea, \*Path of pollutants, DDE, Distribution patterns, Lindane, Polychlorinated biphenyls, Tissue analysis.

The contamination of *Pagurus bernhardus* with PCB (as the sum of concentrations of 36 individual components), p, p'-DDE, HCB, alpha-HCH and Lindane (gamma-HCH) was determined in samples collected between December 1988 and May 1989 in the German Bight. Consistent values of congener composition were shown to exist in the abdo-

## Sources Of Pollution—Group 5B

mens when individual congener levels were expressed as percentages of total composition. This value does not appear to be influenced by total concentration, lipid content of the tissue or the sampling position in the German Bight. A comparison of PCB patterns in the hermit crab and zooplankton shows that *P. bernhardus* accumulated penta-, to decachlorobiphenyls which lack vicinal H atoms in meta-para positions. The body burdens of cyclic organochlorines changed with time, but this change was different for different compounds at the same sampling stations for the same compound. These changes were not correlated to natural seasonal events or changing lipid content of the tissues, but were strongly influenced by their sources. The concentrations of aromatic compounds slightly reflected time integrating characteristics, whereas the alpha/gamma-HCH ratio was useful in identifying sudden changes in the influence of rivers as well as water masses coming from the central North Sea. (Author's abstract)  
W91-01941

#### CHANGE OF WATER QUALITY AND COMPOSITION OF PLANKTON IN THE POND OF RECLAIMED SITE.

Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan).  
For primary bibliographic entry see Field 5E.  
W91-01944

#### UTILIZATION OF HYDROCARBON SUBSTRATES BY HEAVY OIL-DEGRADING BACTERIA ISOLATED FROM THE SEA WATER OF OIL-POLLUTED BISHAN SETO.

Shimonoseki Univ. of Fisheries (Japan). Lab. of Microbiology.  
For primary bibliographic entry see Field 5G.  
W91-01945

#### GROUNDWATER TREATMENT WITH ZERO AIR EMISSIONS.

Peroxidation Systems, Inc., Gardena, CA.  
For primary bibliographic entry see Field 5G.  
W91-01946

#### ZINC AND COPPER IN FISH FROM NATURAL WATERS AND REARING PONDS IN NORTHERN ITALY.

Bologna Univ. (Italy). Ist. di Biochimica.  
E. Carpena, O. Cattani, G. P. Serrazanetti, G. Fedrizzi, and P. Cortesi.  
Journal of Fish Biology JFIB9, Vol. 37, No. 2, p 293-299, August 1990. 1 fig, 7 tab, 20 ref.

Descriptors: \*Bioaccumulation, \*Copper, \*Fish, \*Path of pollutants, \*Zinc, Absorption, Bass, Goldfish, Heavy metals, Liver, Muscle.

Zinc and copper were detected in several tissues of fresh and saltwater fish. Liver concentrations of heavy metals varied widely, with respect to the storage and detoxication functions of the organ. In muscle tissues the two metals were linked to aerobic metabolism, and were higher in the heart and lower in the white muscle. High levels of zinc were found in the female gonad, while in the brain zinc levels were more constant and possibly regulated better than copper. In sea bass supplemented with artificial diets no correlation was found between the metal content in the diet and that of the tissue. In goldfish attempts to isolate specific metal binding proteins of low molecular weight using gel filtration gave negative results; the metals were mostly bound to ligands excluded from the gel. (Author's abstract)  
W91-01958

#### COMPARATIVE STUDY ON THE TOXICITY, ABSORPTION AND DEPURATION OF FENITROTHION AND ITS OXON IN JAPANESE TIGER SHRIMP.

Kyushu Univ., Fukuoka (Japan). Faculty of Agriculture.  
K. Kobayashi, R. M. Rompas, Y. Oshima, and N. Imada.  
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 56,

No. 6, p 923-928, June 1990. 4 fig, 2 tab, 7 ref.

Descriptors: \*Absorption, \*Bioaccumulation, \*Depuration, \*Fenitrothion, \*Path of pollutants, \*Pesticide toxicity, \*Pesticides, \*Shrimp, \*Toxicity, \*Water pollution effects, Degradation, Fenoxon, Juvenile growth stage.

A comparative study was made of the toxicity, absorption and depuration of fenitrothion (dimethyl 3-methyl-4-nitrophenyl phosphorothionate; FS) and its oxon (FO) in Japanese tiger shrimp *Penaeus japonicus*. It was previously reported that the toxicity of FO to the shrimp was approximately 10-20 times higher than that of FS in the intramuscular administration test, and also that FO showed about 12,000 times higher acetylcholinesterase inhibition compared with FS. In the lethal concentration (LC50) test, however, the toxicity of FO to young and juvenile tiger shrimp was only 1/10-1/50 that of FS, contrary to its toxicity in vivo. The results in the absorption and depuration test of C14-FS and C14-FO for juvenile tiger shrimp juvenile demonstrated that the absorption rate of FS in the shrimp was approximately 40 times that of FO, and that the FS absorbed by the shrimp from surrounding water was rapidly biotransformed to more toxic FO, resulting in the high toxicity of FS to the shrimp compared with FO in the LC50 test. (Author's abstract)  
W91-01960

#### SIMPLE AND RAPID METHOD FOR SCREENING OF HEAVY OIL-DEGRADING BACTERIA FROM MARINE ENVIRONMENT.

Shimonoseki Univ. of Fisheries (Japan). Lab. of Microbiology.  
For primary bibliographic entry see Field 5G.  
W91-01961

#### PREDICTION OF MINE DRAINAGE QUALITY IN PENNSYLVANIA.

Pennsylvania Dept. of Environmental Resources, Harrisburg. Div. of Mine Drainage Control and Reclamation.  
K. B. C. Brady, and R. J. Hornberger.  
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 5, p 8-15, September/October 1990. 9 fig, 17 ref.

Descriptors: \*Acid mine drainage, \*Coal mining effects, \*Mine wastes, \*Pennsylvania, \*Water quality, Carbonates, Groundwater pollution, Path of pollutants, Pyrite, Sulfur, Water pollution sources, Weathering.

Numerous factors must be considered to predict post-mining water quality from surface coal mines. Factors considered in Pennsylvania are post-mining water quality on similar or adjacent mine sites, premining water quality, lithologic factors, weathering of overburden, and overburden analysis (a chemical analysis of the rock to be disturbed by mining). Examining of post mining water quality is limited where stratigraphic or chemical changes occur between sites, mining practices such as disposal of high sulfur coal refuse may adversely affect water quality, multiple seam mining has occurred and the observed water quality can not be tied to one particular coal seam or overburden, and hydrologic complications make it difficult to relate water quality to previous mining. Premining water quality can be a useful indicator of overburden chemistry. The presence of predominantly sandstone overburden has been linked to acid mine drainage due to the inability of this lithology to neutralize acid generated by ion exchange. Weathering processes can result in the near surface dissolution of carbonates. Acid-base accounting is the most commonly used method of overburden analysis in Pennsylvania. This technique identifies potentially alkaline and acidic strata by laboratory analysis of rock obtained from drill holes. Neutralization potential and sulfur content of rock should also be tested when evaluating mining strata. Strata with neutralization potentials of <30 tons/1000 tons do not generally contribute significant alkalinity to post mining water quality. Strata with sulfur contents >0.5% and low neutralization potential will generally form acid mine drainage. (Geiger-PTT)

W91-01963

#### PRESENCE OF POLYCHLORINATED DIBENZO-P-DIOXINS AND POLYCHLORINATED DIBENZOFURANS IN FISH-EATING BIRDS AND FISH FROM THE NETHERLANDS.

Amsterdam Univ. (Netherlands). Lab. of Environmental and Toxicological Chemistry.  
M. Van den Berg, F. Blank, C. Heeremans, H. Wagenaar, and K. Olie.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 2, p 149-158, March 1987. 3 fig, 8 tab, 37 ref.

Descriptors: \*Bioaccumulation, \*Dioxins, \*Netherlands, \*Path of pollutants, \*Polychlorinated biphenyls, \*Water birds, Animal tissues, Cormorants, Eel, Fish, Food chains, Grebes, Herons, Metabolites, Tissue analysis.

In the period 1980 to 1982, 19 Cormorants (*Phalacrocorax carbo*), three Grey Herons (*Ardea cinerea*) and one Great Crested Grebe (*Podiceps cristatus*) were collected in The Netherlands. The livers of these fish-eating species were analyzed for polychlorinated dibenzo-p-dioxins and dibenzofurans. Only congeners with a 2,3,7,8-chlorine substitution pattern were found in the livers. Major components were 2,3,4,7,8-pentachlorodibenzofuran and 1,2,3,6,7,8-hexachlorodibenzop-dioxin. 2,3,7,8-Tetrachlorodibenzop-dioxin and 1,2,3,7,8-pentachlorodibenzop-dioxin were also present. Six pooled samples of the Eel *Anguilla anguilla*, showed the same congener pattern of chemicals as found in these bird species. In the Eel, 2,3,4,7,8-pentachlorodibenzofuran and 1,2,3,6,7,8-hexachlorodibenzop-dioxin were generally present in the 1 to 5 ng/kg range. Since the Eel is the Cormorant's major food, this indicates strong bioaccumulation for both congeners in the liver of the Cormorant. Significant correlations were found between the various congeners retained in the liver of the Cormorant. It is proposed that this is a result of continuous exposure to a relatively stable background mixture, probably originating from fish consumption. Based on the congener patterns found in the Cormorant, polychlorinated biphenyls and pentachlorophenol are suggested as major contaminating sources for this species. Using results from the Cormorants, an open one compartment model was applied to estimate concentrations of 2,3,4,7,8-pentachlorodibenzofuran in the Eel. These calculations were in good agreement with the actual measurements found in the Eels. (Author's abstract)  
W91-01966

#### EFFECTS OF SAMPLE PREPARATION ON MEASURED CONCENTRATIONS OF EIGHT ELEMENTS IN EDIBLE TISSUES OF FISH FROM STREAMS CONTAMINATED BY LEAD MINING.

National Fisheries Contaminant Research Center, Columbus, OH. Field Research Station.  
For primary bibliographic entry see Field 5A.  
W91-01968

#### HEAVY METAL ACCUMULATIONS AND THEIR RECENT CHANGES IN SOUTHERN MINKE WHALES BALAENOPTERA ACUTOROSTRATA.

Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.  
K. Honda, Y. Yamamoto, H. Kato, and R. Tatsukawa.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 2, p 209-216, March 1987. 8 fig, 2 tab, 39 ref. Ministry of Education, Science and Culture of Japan Project 58030020, 59030053 and 60030060.

Descriptors: \*Antarctic, \*Bioaccumulation, \*Heavy metals, \*Marine pollution, \*Minke whales, \*Path of pollutants, \*Water pollution effects, \*Whales, Atomic absorption spectrophotometry, Cadmium, Distribution patterns, Food chains, Iron, Lead, Mercury, Seals.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

The concentrations of heavy metals in the livers of southern minke whales, *B. acutorostrata*, were determined by atomic absorption spectrophotometry, and their accumulation levels and variations were compared to food habit, and biological parameters. The concentration levels and bioconcentration factors of metals in the minke whale were relatively high for iron (Fe) and cadmium (Cd) and low for mercury (Hg), when compared to seals and small-toothed cetaceans from different waters. For most of the metals examined, the concentrations were log-normally distributed. The concentrations of Fe, Cd, and Hg were positively correlated with age, but a correlation was not observed for the other metals. While the hepatic Fe concentration linearly increased with age, the concentrations of Cd and Hg increased up to the age of about 20 years and thereafter decreased year by year. Such unusual age trends of Cd and Hg are considered to be due to recent changes in the amount of food intake by the minke whale, as a result of structural disturbances in the Antarctic marine ecosystem due to commercial whaling. Also, the hepatic concentrations of metals varied between sexes, and with reproductive status of the matured female; the concentration of Fe was lower in females than males, and Fe, Pb, Ni, and Co concentrations in matured females decreased with progress of gestation. (Author's abstract)  
W91-01969

**MUTAGENIC ACTIVITY OF SURFACE WATERS ADJACENT TO A NUCLEAR FUEL PROCESSING FACILITY.**  
Georgia Univ., Athens. Dept. of Food Science and Technology.  
For primary bibliographic entry see Field 5C.  
W91-01972

**DRILLING FLUIDS AND THE ARCTIC TUNDRA OF ALASKA: ASSESSING CONTAMINATION OF WETLANDS HABITAT AND THE TOXICITY TO AQUATIC INVERTEBRATES AND FISH.**  
National Fisheries Contaminant Research Center, Jackson, WY. Jackson Field Station.  
D. F. Woodward, E. Snyder-Conn, R. G. Riley, and T. R. Garland.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 3, p 683-697, September 1988. 2 fig, 9 tab, 40 ref. US Dept. of Energy and Battelle Pacific Northwest Laboratory Agreement DW89930699.

Descriptors: \*Alaska, \*Drilling fluids, \*Fish, \*Invertebrates, \*Oil pollution, \*Path of pollutants, \*Toxicity, \*Tundra, \*Wastewater pollution, \*Water pollution effects, \*Wetlands, Aquatic habitats, Arctic, Bioassay, Chemical analysis, Daphnia, Hydrocarbons, Population exposure, Sediment analysis.

Drilling for oil on the North Slope of Alaska results in the release of large volumes of used drilling fluids into arctic wetlands. These releases, usually come from regulated discharges or seepage from reserve pits constructed to hold used drilling fluids. A study of five drill sites and their reserve pits showed an increase in common and trace elements and organic hydrocarbons in ponds near to and distant from reserve pits. Ions elevated in water were barium, chlorine, chromium, potassium, sulfate, and zinc. Concentrations of copper, chromium, iron, lead and silicon in sediments were higher in near and distant ponds than in control ponds. The predominant organics in drill site waters and sediments consisted of aromatic and paraffinic hydrocarbons characteristic of petroleum or a refined product of petroleum. In 96-hour exposures in the field, toxicity to *Daphnia middendorffiana* was observed in water from all reserve pits, and from two of five near ponds, but not from distant ponds. In laboratory tests with *Daphnia magna*, growth and reproduction were reduced in dilutions of 2.5% drilling fluid (2.5 drilling fluid: 97.5 dilution water) from one reserve pit, and 25% drilling fluid from a second. Growth and reproduction were not affected at these dilutions of fluid from the other three reserve pits. Additional regulations—such as an upper limit on aromatic hydrocarbon content and toxicity to sensitive orga-

nisms—are needed to improve safety for aquatic organisms in habitats receiving used drilling fluids. (Author's abstract)  
W91-01975

**INFLUENCE OF TEMPERATURE AND ORGANIC AMENDMENTS ON THE MOBILIZATION OF SELENIUM IN SEDIMENTS.**  
California Univ., Riverside. Dept. of Soil and Environmental Sciences.  
S. J. Calderone, W. T. Frankenberger, D. R. Parker, and U. Karlsson.  
Soil Biology & Biochemistry SBOAH, Vol. 22, No. 5, p 615-620, 1990. 6 fig, 3 tab, 25 ref.

Descriptors: \*Kesterson Reservoir, \*Leaching, \*Path of pollutants, \*Reservoir sediments, \*Sediment contamination, \*Selenium, California, Detoxification, Heavy metals, Kinetics, Manure, Proteins, Sediment analysis, Temperature effects, Volatility.

Toxic amounts of selenium have been found in sediments and water at Kesterson Reservoir (Merced County, CA). A sediment column study was established for determination of Se volatilization potential and k Se volatilization rate coefficient derived from a first-order kinetics model. Increasing the temperature from 15 to 35 °C promoted volatilization of Se. The amount of Se leached out of the sediments was independent of the initial total Se inventory. Volatilization of Se followed a first-order reaction and was highly dependent on initial Se concentration. The Se volatilization potential ranged from 0.18 to 3.63 mg Se/kg sediment with rate coefficients values ranging from 0.003 to 0.053/day. The addition of organic amendments promoted volatilization, with Se being less available for leaching. The application of gluten, a wheat storage protein, enhanced volatilization of Se (1.7 to 3.2-fold over the control) more strongly than other treatments (e.g. casein, orange peel and cattle manure). Volatilization may be an important dissipation mechanism for detoxification of seleniferous sediments. (Author's abstract)  
W91-01990

**TRANSPORT OF HEAVY METALS WITHIN A SMALL URBAN CATCHMENT.**  
Middlesex Polytechnic, Enfield (England). Urban Pollution Research Center.  
D. M. Revitt, R. S. Hamilton, and R. S. Warren.  
The Science of the Total Environment STENDL, Vol. 93, p 359-373, April 1990. 2 fig, 8 tab, 17 ref.

Descriptors: \*Cadmium, \*Copper, \*Heavy metals, \*Lead, \*Model studies, \*Path of pollutants, \*Urban drainage, \*Urban runoff, \*Zinc, Air pollution, Deposition, Hydrologic models, Hydrology, Runoff, Storm runoff.

A small urban catchment has been monitored for levels of lead, zinc, cadmium and copper in the atmosphere, deposition, surface dust and storm-water runoff. The contribution of local emissions to total deposition was considered and found to be significant only for zinc. In rainfall, the metals are mainly associated with particulates. Wet deposition is more important than dry deposition for lead and zinc, but the processes are comparable for cadmium and copper. The percentage of the dissolved metal level in rainfall (which was observed in the storm runoff) varied from 92% for copper to 13% for lead. The mass of metal removed in runoff is the combined metal input by wet and dry deposition to the road and roof surface less that mass of metal which is: (1) adsorbed onto surface sediments; (2) retained by the gully pots; (3) retained in the roof guttering; (4) deposited in the underground drainage system; (5) lost through resuspension and dispersion; and (6) removed by street sweeping. The hydrologic characteristics of each storm event need to be accommodated for any predictive model of this type to be valuable. Even then, the result will be dependent on specific site characteristics. (Stoehr-PTT)  
W91-01992

**SUBSTANCE LOAD IN RAINWATER RUNOFF FROM DIFFERENT STREETS IN HAMBURG.**

Hamburg Univ. (Germany, F.R.). Inst. fuer Anorganische und Angewandte Chemie.  
W. Dannecker, M. Au, and H. Stechmann.  
The Science of the Total Environment STENDL, Vol. 93, p 385-392, April 1990. 4 tab, 3 ref.

Descriptors: \*Germany, \*Hamburg, \*Path of pollutants, \*Storm runoff, \*Urban runoff, \*Water pollution sources, Antimony, Arsenic, Cadmium, Chromium, Copper, Heavy metals, Highway effects, Pollutant identification, Runoff, Surface runoff, Vanadium, Zinc.

Twenty-five substances were evaluated in runoff, and wet and bulk deposition samples from different sampling sites in Hamburg, Germany: (1) a street in an industrial area; (2) a thoroughfare; and (3) a small street in a residential area. The runoff from the industrial road and the main street showed similar levels of pollution. The surface water from the industrial area contained higher concentrations of arsenic, while the main street showed higher concentrations of lead, antimony and zinc. The runoff from the residential area was loaded substantially lower. Several elements, copper, chromium, and vanadium were found to be almost completely adsorbed to particles, but several more toxic elements, cadmium and copper, were found at a higher percentage in the soluble phase. (Author's abstract)  
W91-01993

**POLLUTION OF STREET RUN-OFF BY TRAFFIC AND LOCAL CONDITIONS.**  
Umweltbundesamt, Berlin (Germany, F.R.).  
W. Muschack.

The Science of the Total Environment STENDL, Vol. 93, p 419-431, April 1990. 6 tab, 12 ref.

Descriptors: \*Highway effects, \*Pollutant identification, \*Urban runoff, \*Water pollution sources, Chromium, Copper, Drinking water, Heavy metals, Hydrocarbons, Lead, Nickel, Path of pollutants, Precipitation, Rainwater, Runoff, Zinc.

Investigations were performed in the Federal Republic of Germany to determine pollutant concentrations in rainwater in order to obtain a comprehensive picture of the pollution caused by precipitation runoff. Influencing parameters included: exhaust gases, tire abrasion particles, brake lining abrasion dust, leakage of hydrocarbons, and winter street cleaning activities. The analysis of these factors was complemented by the determination of detection limits. After an assessment of all possibilities, 30 substances remained, and 22 were analyzed. Lead, chromium, copper, nickel, and zinc are the elements commonly found in the emissions/particles of the aforementioned parameters. (Stoehr-PTT)  
W91-01994

**HEAVY METAL ACCUMULATION AND TRANSPORT THROUGH DETENTION PONDS RECEIVING HIGHWAY RUNOFF.**

University of Central Florida, Orlando. Dept. of Civil Engineering and Environmental Sciences.  
Y. A. Yousef, T. Hvitved-Jacobsen, H. H. Harper, and L. Y. Lin.

The Science of the Total Environment STENDL, Vol. 93, p 433-440, April 1990. 2 fig, 3 tab, 10 ref.

Descriptors: \*Heavy metals, \*Highway effects, \*Path of pollutants, \*Settling basins, \*Urban runoff, \*Water pollution sources, Chemical analysis, Copper, Lead, Municipal wastewater, Nickel, Rainfall, Runoff, Sediments, Zinc.

Heavy metals in highway runoff entering detention and retention ponds are removed, and accumulate in the bottom sediments of these ponds. Removal efficiency is controlled by: particulate metal fraction; detention time in the pond; and physical, chemical and biological interactions. Ponds tested have been in operation for five to fifteen years. Sediment accumulation rates vary between 1 cm/yr to 4 cm/yr. Metal concentrations throughout the sediment show a rapid decline following an exponential decay; the majority of the metals are attenuated in the top 10 to 20 centimeters. This

## Sources Of Pollution—Group 5B

relatively high concentration of metals in the top layer suggests that the majority of particulate metals may settle out quickly upon entering the pond. Also the metal content in the sediment is generally lower than required standards of metals in municipal wastewater sludges recommended for agricultural use (< 900 microgm of copper, 1000 microgm of lead, 100 microgm of nickel, and 1800 microgm zinc per gram dry weight sediments). The potential release of heavy metals from bottom sediments under pH values of 7.5 to 8.5, by changing the redox potential from strongly oxidized to strongly reduced conditions, is insignificant. But, lowering the pH to 5 may enhance the release of metals. Generally, the amount of metal released is a small proportion of the metal content in the sediments. Based on the United States Environmental Protection Agency Toxicity Characteristics Leaching Procedures (TCLP) tests, disposal of bottom sediments in sanitary landfills may be feasible. Additional research studies are in progress to confirm these conditions. (Stoehr-PTT) W91-01995

#### POLLUTANTS ATTACHED TO PARTICLES FROM DRAINAGE AREAS.

Karlsruhe Univ. (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft. C. Xanthopoulos, and H. H. Hahn. The Science of the Total Environment STENDL, Vol. 93, p 441-448, April 1990. 1 fig, 3 tab, 8 ref.

Descriptors: \*Drainage area, \*Heavy metals, \*Particle size, \*Path of pollutants, \*Urban runoff, \*Water pollution sources, Drainage systems, Pollutant load, Runoff, Storm runoff, Surface runoff, Urban areas, Water pollution.

Toxic substances, such as heavy metals or organic priority pollutants, are of particular interest to the pollution of natural waters from urban areas. Preliminary investigations at four different stations within the Karlsruhe, Germany, drainage area indicate that these substances may exist at high concentration levels. In particular, autumn falling leaves cause solid concentrations of 1000-2000 mg suspended solids/L. Observed metal concentrations (Pb, Zn, Cu, Cd) in Karlsruhe are at the top end of the spectrum reported so far. The dissolved and the particle-bound phases were examined separately after separation using a centrifuge. The low concentrations in one fraction show that the examined organic micropollutants (e.g. polycyclic aromatic hydrocarbons, PAC) are predominantly linked to solids. The PAC (fluoranthene, benzofluoranthene, indeno-pyrene, benz-a-pyrene, and benz-perylene) contents of the whole sample exceed drinking water standards by a factor of 10. The PAC contents of the particles separated by centrifuge correspond to the top end of concentrations observed in sewage sludge. The polychlorinated biphenyl (PCB) load of the total sample (calc. as clophen A60) is approximately 150 ng/L, and does not exceed drinking water standards both for individual substances and in total. Examination of the pollutants among the various size fractions of particulates confirmed that the fine fractions (0.08-0.2 mm) carry significantly higher loads. The coarse fraction (> 1 mm) is transported as bed load in the sewer system. It is important for the operation of the drainage system, but plays only a minor role in the transport of pollutants. The second fraction (0.2-1 mm) is transported near the bottom of the sewer, and in times of low discharges may sediment out. Since the pollutant load of these two fractions is small they have little influence on the transported amount of pollutants. The third fraction (0.08-0.2 mm) is transported in suspended form, and depending on the current flow conditions, occurs in either heterogeneous or homogeneous concentration profiles. The finer solids (< 0.08 mm) move more simultaneously with the stormwater runoff and are distributed homogeneously. The two latter fractions are most decisive in explaining the transport of pollutants in the catchment and drainage system. (Stoehr-PTT) W91-01996

#### DISTRIBUTION OF HYDROCARBON CONCENTRATIONS FROM URBAN RUNOFF.

Universidad Politécnica de Madrid (Spain). Es-

cuela Técnica Superior de Ingenieros de Caminos. M. T. Bombol, A. Hernandez, F. Marino, and E. Hontoria. The Science of the Total Environment STENDL, Vol. 93, p 465-480, April 1990. 9 fig, 5 ref.

Descriptors: \*Aliphatic hydrocarbons, \*Hydrocarbons, \*Path of pollutants, \*Statistical analysis, \*Urban runoff, \*Water pollution sources, Frequency distribution, Madrid, Regression analysis, Runoff, Spain, Water sampling.

Hydrocarbon runoff data from Madrid, Spain, have been analyzed in order to determine the effect of time, area characteristics and water flow on the runoff concentration frequency distribution. In this study, aliphatic and aromatic hydrocarbon concentrations obtained from runoff sampling from different areas of Madrid at different times of the year were used. The cumulative frequency distributions of a number of the hydrocarbons are characterized as modal log-normal distributions. This statistical study indicates a linear expression which relates aliphatic hydrocarbons from natural anthropogenic origins, with aromatic hydrocarbons from anthropogenic origins. Basically, those found in this urban runoff have noxious and harmful effects on human health and the environment. Upon consideration (of the concentrations of hydrocarbons from the areas of Madrid with different characteristics, distinct traffic levels, and the varying seasons) this linear expression is very useful for determining these compounds whenever qualities of the city are the same. (Stoehr-PTT) W91-01998

#### INFLUENCE OF COMPLEXING AGENTS AND SURFACTANTS ON METAL SPECIATION ANALYSIS IN ROAD RUNOFF.

Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Sanitary Engineering. For primary bibliographic entry see Field 5A. W91-01999

#### APPLICATION OF MULTIVARIATE ANALYSIS FOR CHARACTERIZATION OF ORGANIC COMPOUNDS FROM URBAN RUNOFF.

Universidad Politécnica de Madrid (Spain). Escuela Técnica Superior de Ingenieros de Caminos. For primary bibliographic entry see Field 5A. W91-02004

#### IRON AND MANGANESE GEOCHEMISTRY AND THE DISTRIBUTION OF 239, 240 PU AND 241 AM IN THE SEDIMENTS OF THE NORTH EAST IRISH SEA.

Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Directorate of Fisheries Research. S. J. Malcolm, P. J. Kershaw, N. J. Cromar, and L. Botham.

The Science of the Total Environment STENDL, Vol. 95, p 69-87, June 1990. 5 fig, 4 tab, 42 ref.

Descriptors: \*Americium, \*Geochemistry, \*Heavy metals, \*Irish Sea, \*Iron, \*Manganese, \*Path of pollutants, \*Plutonium, \*Radioactive wastes, \*Sediment contamination, \*Sediment discharge, \*Sediment distribution, Leaching, Nuclear powerplants, Sediment-water interfaces, Trace elements.

The geochemical cycling of iron and manganese within the seabed sediments of the northeast Irish Sea has been investigated in an attempt to learn more about the factors controlling the distribution and behavior of plutonium and americium released from the BNFL plc nuclear fuel reprocessing plant at Sellafield, England. Enrichment of surface sediment with both iron and manganese results from active diagenetic redox behavior which produces characteristic interstitial water concentration profiles at particular sites. The shape of the interstitial water profiles is controlled by differences in the general bioturbation regimes at each site. This factor has been simulated in simple laboratory tank experiments. Evidence from selective chemical leaching suggests that 40 percent of the plutonium and 80 percent of the americium are associated with the operationally defined iron/manganese oxide phase. However, in the surface sediment

there is no apparent correlation between either iron or manganese content and either the plutonium or americium concentrations determined by strong acid digestion of the samples. Fluxes of iron and manganese upward in sediment are similar to those measured at other nearshore sites and indicate a potential for oxide scavenging of trace elements at the sediment/water interface. The behavior of plutonium and americium has probably been dominated by general nonequilibrium conditions resulting from the recent introduction of the plutonium and americium into the environment, the dominating effects of dispersion from the pipeline source, and the variation with time of the quantities discharged. (Author's abstract) W91-02006

#### MASS-BALANCE OF METALS AND IDENTIFICATION OF THEIR SOURCES IN BOTH RIVER AND FALLOUT FLUXES NEAR GDANSK BAY, BALTIC SEA.

Akademia Medyczna, Gdansk (Poland). Dept. of Analytical Chemistry. P. Szefer.

The Science of the Total Environment STENDL, Vol. 95, p 131-139, June 1990. 2 tab, 28 ref.

Descriptors: \*Estuaries, \*Fallout, \*Heavy metals, \*Metals, \*Path of pollutants, \*Poland, \*Rivers, Baltic Sea, Cadmium, Chemical analysis, Cobalt, Copper, Geomorphology, Lead, Manganese, Nickel, Particulate matter, Rainfall, Thorium, Uranium, Water pollution, Zinc.

Metals concentration data are utilized to estimate the total observed metal fluxes in estuarine water of the Vistula River and rain fallout near the coastal zone of Gdansk Bay. The flux ratio (FR) between the observed flux (F) and the theoretical flux (F sub t), as well as the enrichment factor (EF), were calculated for each metal in order to evaluate its origin in estuarine river water and rain fallout. The F sub t value was derived from the mean metal content in the earth's crust and the total quantity of weathered land material. Iron was used as the normalizing element because of the lack of aluminum data. The FR and F values were balanced, and are similar to the EF values for less-mobilized trace metals such as copper and thorium in the Vistula flux and thorium, uranium, manganese and nickel in rain fallout. For these metals no enrichment relative to iron is observed in particulate matter. Additional fluxes in both the river and atmospheric components were found for cadmium, lead, zinc, and copper. This may be due to the influence of natural sources or artificial sources such as pollution. Literature data indicate insignificant contributions of lead, cadmium, zinc and copper from these natural sources, hence it may be concluded that the four metals were of anthropogenic origin. (Author's abstract) W91-02007

#### DISTRIBUTION OF ZINC, LEAD, CADMIUM AND COPPER BETWEEN DIFFERENT SIZE FRACTIONS OF SEDIMENTS I. THE LIMSKI KANAL (NORTH ADRIATIC SEA).

Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.

D. Martincic, Z. Kwokal, and M. Branica. The Science of the Total Environment STENDL, Vol. 95, p 201-215, June 1990. 4 fig, 4 tab, 34 ref.

Descriptors: \*Adriatic Sea, \*Cadmium, \*Geochemistry, \*Heavy metals, \*Lead, \*Path of pollutants, \*Sediment contamination, \*Sediments, \*Zinc, Carbonates, Clays, Correlation analysis, Organic matter, Particle size, Sediment distribution, Silt, Trace elements.

The grain size distribution of particles and their accumulation in surface sediments of the upper part of Limski Kanal were determined. At all sampling stations, the size fractions containing particles less than 20 micrometers (clay-silt fraction) were predominant, whereas the amount of coarser grains was less than 30%. The quantities of associated metals within these size fractions differed from one sampling station to another. In all sediments, the finest clay-silt fraction (less than 10

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources Of Pollution

micro meters) contained the high concentration of all metals. The pattern of association of metals with coarser fraction changed substantially between sediments, depending on their chemical characteristics. Generally, they contained amounts of incorporated metals similar to, or even higher than, those found in the clay-silt fraction. These observations are primarily attributed to the quantities of organic and biogenic carbonate. Metal distributions are significantly correlated with the organic material in the sediments. No general trends were observed in the spatial distribution of metals in the sediment less than 300 micro meters from the area studied. The temporal metal variations at some sampling sites coincided with temporal variations in the organic material contents. (See also W91-02010) (Stoehr-PTT) W91-02009

#### DISTRIBUTION OF ZINC, LEAD, CADMIUM AND COPPER BETWEEN DIFFERENT SIZE FRACTIONS OF SEDIMENTS II. THE KRKA RIVER ESTUARY AND THE KORNATI ISLANDS (CENTRAL ADRIATIC SEA).

Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research. D. Martincic, Z. Kwokal, and M. Branica. The Science of the Total Environment STENDL, Vol. 95, p 217-225, June 1990. 2 fig, 1 tab, 5 ref.

Descriptors: \*Adriatic Sea, \*Estuaries, \*Geochemistry, \*Heavy metals, \*Path of pollutants, \*Rivers, \*Sediment contamination, \*Sediment distribution, \*Sediments, Cadmium, Clays, Copper, Industrial wastes, Lead, Particle size, Silt, Trace elements, Zinc.

The levels of zinc, cadmium, lead and copper in different grain size fractions of recent sediments, collected from the Krka River Estuary and the Kornati Islands during October 1983, were determined. The distributional patterns of these metals mainly depended on the textural characteristics of the sediment. The clay-silt size particles contained the highest amounts of zinc, cadmium and lead. Copper exhibited an irregular particle size distribution. In general, the contents of copper in different grain-size fractions and their distribution throughout the area seemed to be influenced by biological activities. In the coastal region, the concentrations of cadmium in the coarse particles appeared to coincide with the quantities of carbonate present in the sediments. A significant enrichment of lead was observed in the lower part of the Krka River Estuary and in coastal regions with intensive ship traffic. Sediment collected near an industrial waste outflow was found to be enriched with zinc, lead and copper of anthropogenic origin. (See also W91-02009) (Author's abstract) W91-02010

#### PHTHALATE ESTERS IN RIVERS OF THE GREATER MANCHESTER AREA, U.K.

Obafemi Awolowo Univ., Ile-Ife (Nigeria). Dept. of Chemistry. O. S. Fatoki, and F. Vernon. The Science of the Total Environment STENDL, Vol. 95, p 227-232, June 1990. 1 fig, 1 tab, 17 ref.

Descriptors: \*Effluents, \*England, \*Esters, \*Industrial wastes, \*Phthalate esters, \*Rivers, \*Water pollution sources, Chemical analysis, Gas chromatography, Mass spectrometry, Pollutants, Sewage, Wastewater, Water pollution.

Waters from the Rivers Irwell and Etherow and from the Prestwich sewage treatment plant effluent, Manchester, England were analyzed for the presence of phthalate esters using computer-assisted gas chromatography and mass spectrometry (GC and MS). Extraction was with  $\text{CHCl}_3$ . Liquid chromatography clean up was used for compound separation. Several phthalate esters, such as diethyl, butyl-2-monopropyl, di-n-butyl, di-2-ethyl-hexyl and di-iso-octyl, were found to be present at 0.4 to 33.5 micro grams per liter. A study on uncontaminated waters was undertaken to establish blank levels. The results compare favorably with those reported elsewhere for rivers polluted with industrial chemicals. The occurrence of phthalate esters in Manchester rivers is consistent with the

industrial activities of the city. Other probable sources include leaching from disposed plastic wastes. Levels of phthalate esters in the city sewage effluent were considerably lower than those in the Irwell. (Author's abstract) W91-02011

#### PENTACHLOROPHENOL: ENVIRONMENTAL PARTITIONING AND HUMAN EXPOSURE.

Oak Ridge National Lab., TN. Office of Risk Analysis. H. A. Hattermer-Frey, and C. C. Travis. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 482-489, July/August 1989. 7 tab, 56 ref.

Descriptors: \*Bioaccumulation, \*Biocides, \*Food chains, \*Human health, \*Human population, \*Mathematical models, \*Path of pollutants, \*Pentachlorophenol, \*Public health, \*Toxicity, Aquatic life, Equilibrium, Fugacity-food chain model, Soil contamination, Suspended sediments, Water pollution.

Pentachlorophenol (PCP) is used as a wood preservative and a biocide, and is toxic to humans. The Fugacity-Food Chain model estimates the concentration of a chemical in six media (air, water, soil, sediment, suspended sediment in water, and biota in water) and then uses those concentrations to predict the amount of chemical entering the food chain and the average daily intake by the general population. The model contains simplifying assumptions, but given the state of knowledge regarding the environmental transport of chemicals, fugacity models are considered acceptable for exploring the equilibrium partitioning and environmental behavior of organic chemicals. Input parameters required to predict the cross-media partitioning of a chemical include its physicochemical and biochemical properties, bioconcentration/bio-transfer factors, estimates of emission rates for the compound into air, water, and soil, and estimates of degradation rate coefficients for reactions that remove the compound from the system. Environmental concentrations of PCP were used to estimate the amount of PCP entering the food chain and the long term, average daily intake of PCP by the general population of the United States. Results show that PCP partitions mainly into soil (96.5%) and that the food chain, especially fruits, vegetables, and grains, accounts for 99.9% of human exposure to PCP. The long term, average daily intake of PCP is estimated to be 16 microg/day, which agrees well with previous estimates of 19 microg per day. (Brunone-PTT) W91-02016

#### ACUTE TOXICITY OF SELECTED HERBICIDES AND SURFACTANTS TO LARVAE OF THE MIDGE CHIRONOMUS RIPARIUS.

National Fisheries Contaminant Research Center, Yankton, SD. Field Research Station. For primary bibliographic entry see Field 5C. W91-02017

#### RAPID DISSIPATION OF GLYPHOSATE IN SMALL FOREST PONDS.

Alberta Univ., Edmonton. Dept. of Botany. L. G. Goldsborough, and A. E. Beck. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 537-544, July/August 1989. 3 fig, 6 tab, 27 ref.

Descriptors: \*Biodegradation, \*Fate of pollutants, \*Glyphosate, \*Herbicides, \*Path of pollutants, \*Ponds, \*Toxicity, Metabolites, Sediment contamination, Water chemistry, Water pollution.

Glyphosate, a broad spectrum herbicide, was applied to the water surface of four small boreal forest ponds and six in situ microcosms at a rate of 0.89 kg a.i./ha. Water samples collected over a period of up to 255 days were analyzed for glyphosate and its primary metabolite aminomethylphosphonic acid (AMPA). Glyphosate dissipated rapidly from all ponds, with first order half-lives ranging from 1.5 to 3.5 days. The slowest dissipation rate occurred in the pond with the most calcareous

water and sediments. Glyphosate remained at or above the treatment concentration in microcosms containing only water but decreased rapidly in the presence of sediments. AMPA levels in ponds and microcosms were consistently low. Concentrations on microcosm wall samples were temporally variable, probably as a result of adsorption to periphytic biofilms. Glyphosate in the sediments of treated microcosms generally increased with time during the period of observation. These results confirm that glyphosate dissipates rapidly from the surface waters of lentic systems, and suggest that sediment absorption or biodegradation were the major means of glyphosate loss from the water column. These results suggest that effects of glyphosate contamination in water will be minimal, although further work is needed to evaluate possible long term toxicological effects. (Author's abstract) W91-02018

#### EFFECTS OF CADMIUM ON MUREX TRUNCULUS FROM THE ADRIATIC SEA: I. ACCUMULATION OF METAL AND BINDING TO A METALLOTHIONEIN-LIKE PROTEIN.

Innsbruck Univ. (Austria). Inst. fuer Zoologie. R. Dallinger, E. Carpena, G. J. Dalla Via, and P. Cortesi. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 554-561, July/August 1989. 4 fig, 3 tab, 35 ref. Fonds zur Forderung der Wissenschaftlichen Forschung, Austria, Project No. P5962.

Descriptors: \*Adriatic Sea, \*Bioaccumulation, \*Cadmium, \*Heavy metals, \*Metallothioneins, \*Mollusks, \*Toxicity, \*Toxicology, \*Water pollution effects, Amino acids, Gel chromatography, Ion exchange chromatography, Molecular structure, Snails, Tissue analysis, Zinc.

Individuals of *Murex trunculus* from the Adriatic Sea were exposed in the laboratory to cadmium under chronic conditions (0.05 mg/L, up to 30 days). Cadmium contents in the soft parts of the snails increased considerably, the highest concentrations occurring in combined hepatopancreas and kidney tissues. However, high amounts of cadmium were also found in unexposed individuals. No significant changes were observed in the concentrations of zinc. Cytosolic fractions of hepatopancreas and kidney organs were separated by gel and ion exchange chromatography. Variable amounts of cadmium were associated with components with a molecular weight of more than 75000 Daltons. Most of the metal, however, was bound to a protein with an apparent molecular weight of 11000 Daltons. This protein showed low absorption at 280 and a higher one at 254 nm. Amino acid composition revealed high amounts of cysteine (26%), lack of tyrosine, but presence of phenylalanine (4%). On the basis of these features, the protein was identified as a metallothionein-like protein. With increased exposure time, cadmium replaced zinc from this protein with zinc moving towards fractions with a molecular weight of less than 3000 Daltons. Moreover, a spillover effect was observed: the cadmium content of the metallothionein-like protein increased up to a saturation point beyond which excess cadmium was bound to high molecular weight components. (See also W91-02021) (Author's abstract) W91-02020

#### UPTAKE AND ELIMINATION OF WATERBORNE CADMIUM BY THE FISH NOEMACHEILUS BARBATULUS L. (STONE LOACH).

Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station. For primary bibliographic entry see Field 5C. W91-02023

#### SHELL AS A SITE OF LEAD DEPOSITION IN HELIX ASPERSA.

Polytechnic of the South Bank, London (England). Dept. of Biotechnology. A. Beeby, and L. Richmond. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 623-628, July/August 1989. 3 fig, 2 tab, 25 ref.

## Effects Of Pollution—Group 5C

Descriptors: \*Bioaccumulation, \*Heavy metals, \*Lead, \*Mollusks, \*Path of pollutants, \*Toxicity, Calcium, Magnesium, Metabolism, Shells, Snails.

Snails from a contaminated urban car park were fed an experimental diet for 64 days. One group received a high lead diet for the duration, and another group was removed from the high lead diet after two days. Shells were analyzed at various intervals to measure lead uptake and loss. Regression analysis of twenty eight shells for each treatment suggests that the weight of lead in the shell increased linearly with time, but loss from the shell was correlated with soft tissue lead levels. The shells of fourteen snails from an uncontaminated site accumulated lead less quickly on the high lead diet and had lower magnesium and calcium concentrations. All snails lost magnesium from the shell following the initial dose, possibly as part of the detoxification mechanism for heavy metals. The shell may lose lead over a number of days, serving as a short term sink for lead which it releases when soft tissue concentrations fall. (Author's abstract)

W91-02025

#### TOXICITY AND BIOACCUMULATION OF SELENATE, SELENITE AND SELENO-L-METHIONINE IN THE CYANOBACTERIUM ANABAENA FLOS-AQUAE.

California Univ., Davis. Dept. of Land, Air and Water Resources.

For primary bibliographic entry see Field 5C.

W91-02028

#### BIOACCUMULATION OF SELENIUM IN BIRDS AT KESTERSON RESERVOIR, CALIFORNIA.

Patuxent Wildlife Research Center, Davis, CA. Pacific Coast Field Station.

For primary bibliographic entry see Field 5C.

W91-02029

#### GEOGRAPHIC VARIATION OF CHLORINATED HYDROCARBONS IN BURBOT (LOTA LOTA) FROM REMOTE LAKES AND RIVERS IN CANADA.

Department of Fisheries and Oceans, Winnipeg (Manitoba). Central and Arctic Region.

D. C. G. Muir, C. A. Ford, N. P. Grift, D. A. Metner, and W. L. Lockhart.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 530-542, July/August 1990. 6 fig, 6 tab, 42 ref.

Descriptors: \*Bioaccumulation, \*Canada, \*Chlorinated aromatic compounds, \*Fish, \*Halogenated pesticides, \*Hydrocarbons, \*Lakes, \*Path of pollutants, \*Pesticides, \*Polychlorinated biphenyls, Ecosystems, Fate of pollutants, Rivers, Water chemistry, Water pollution.

The variation in levels of polychlorinated biphenyls (PCBs), chlorobenzenes and chlorinated pesticides was studied in burbot (*Lota lota*) from eight remote locations along a northwesterly transect from northwestern Ontario to the Mackenzie River delta in Canada. Significant declines in concentrations of PCB congeners, DDT isomers, lindane, dieldrin, and mirex in burbot liver were found with increasing north latitude. Mean PCB concentrations ranged from 1290 ng/g (lipid wt) at Lake 625, a remote lake in northwestern Ontario, to 301 ng/g in samples from the Mackenzie River at Arctic Red River, Northwest Territories. No significant differences in mean concentrations of toxaphene, alpha-HCH(BHC), trichlorobiphenyls, and tetrachlorobiphenyls were observed between southern and northern sampling sites. Toxaphene was the predominant organochlorine residue in northern fish samples averaging 1400 ng/g (lipid wt) at the three most northerly sites and 1723 ng/g at Lake 625. Airborne contamination was the only likely source of organochlorines for most of the locations surveyed. The results were consistent with the hypothesis that inputs of semi-volatile organochlorines to northern aquatic ecosystems decrease with increasing north latitude and distance from North American sources. (Author's abstract)

W91-02033

#### EFFECTS OF XAD-8 FRACTIONS OF DISSOLVED ORGANIC CARBON ON THE SORPTION AND BIOAVAILABILITY OF ORGANIC MICROPOLLUTANTS.

Joensuu Univ. (Finland). Dept. of Biology.

J. Kukkonen, J. F. McCarthy, and A. Oikari.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 551-557, July/August 1990. 3 fig, 3 tab, 23 ref. US DOE Contract DE-AC05-84OR21400.

Descriptors: \*Adsorption, \*Bioavailability, \*Chromatography, \*Organic carbon, \*Path of pollutants, \*Polycyclic aromatic hydrocarbons, \*Water pollution, Bioaccumulation, Daphnia, Fate of pollutants, Ion exchange, Polychlorinated biphenyls, Waterfleas.

The dissolved organic carbon (DOC) from a stream water near a peat deposit was fractionated into hydrophobic-acid (HbA), hydrophobic-neutral (HbN) and hydrophilic (Hl) subcomponents by XAD-8 chromatography. The capacity of these fractions and the total (unfractionated) water to bind hydrophobic organic contaminants was measured by equilibrium dialysis, and the effect of binding on contaminant bioavailability was measured in *Daphnia magna*. Model contaminants were the polycyclic aromatic hydrocarbons, naphthalene (NPH) and benzo(a)pyrene (BaP), and the polychlorinated biphenyl, 2,2',5,5'-tetrachlorobiphenyl (TCB). Both BaP and TCB exhibited high partition coefficients for binding to both the total DOC and the hydrophobic components of the DOC. BaP had a higher affinity for binding to the HbA fraction, while TCB (and three other PCB's) had higher affinity for the HbN fraction. The partition coefficients for binding to the Hl fraction were twofold to tenfold lower than for binding to the hydrophobic fraction. The less hydrophobic compound, NPH, had a much lower partition coefficient, and little difference was seen between the fractions. The total water and the different DOC fractions reduced the uptake and accumulation of BaP and TCB by *D. magna* in proportion to the capacity of the DOC for binding the contaminants. Data were consistent with the hypothesis that a contaminant bound to DOC (total water or any of the fractions) is unavailable for uptake by biota. Uptake of NPH was not substantially affected by the DOC, consistent with its lower partition coefficient. (Author's abstract)

W91-02034

#### CHRONIC TOXICITY AND BIOACCUMULATION OF 2,5,2',5'- AND 3, 4, 3',4'-TETRACHLOROBIPHENYL AND AROCLOR 1242 IN THE AMPHIPOD HYALELLA AZTECA.

Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.

For primary bibliographic entry see Field 5C.

W91-02035

#### COMPARATIVE TOXICOKINETICS OF 2,2'-DICHLOROBIPHENYLS AND 4,4'-DICHLOROBIPHENYLS IN THE POND SNAIL LYMNAEA STAGNALIS.

Vrije Univ., Amsterdam (Netherlands). Dept. of Pharmacology.

For primary bibliographic entry see Field 5C.

W91-02036

#### TOXICOLOGICAL EXAMINATION OF WHITEFISH (COREGONUS CLUPEAFORMIS) AND NORTHERN PIKE (ESOX LUCIUS) EXPOSED TO URANIUM MINE TAILINGS.

Environmental Protection Service, Regina (Saskatchewan).

For primary bibliographic entry see Field 5C.

W91-02037

#### PARTITIONING OF LINDANE BETWEEN SEDIMENT, WATER AND THE CRUSTACEAN METAPENAEUS MACLEAYI.

Griffith Univ., Nathan (Australia). School of Aus-

tralian Environmental Studies.

A. C. Just, D. W. Hawker, and D. W. Connell.

Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 41, No. 3, p 389-397, 1990. 3 fig, 1 tab, 21 ref.

Descriptors: \*Bioaccumulation, \*Crustaceans, \*Halogenated pesticides, \*Lindane, \*Path of pollutants, \*Sediment chemistry, \*Sediment pollution, \*Soil water pollution, \*Water chemistry, Equilibrium, Organic carbon, Partitioning, Shrimp, Uptake.

The partitioning behavior of lindane between sediment, water and the shrimp *Metapenaeus macleayi* was investigated. The sediment-to-water partition coefficient was determined with sealed glass vials in laboratory experiments and found to be 9.52 or 2164 on an organic carbon basis. This result is in agreement with relevant literature data and confirms that the organic matter of the sediment is the primary sorption site in this process. The bioconcentration factor was evaluated from laboratory experiments with shrimps in sealed glass jars in which the lindane seawater solution was changed frequently. Under these conditions, effective equilibrium was attained after 24 hours. Measured uptake and clearance rate constants were smaller than predicted on the basis of existing general relationships between measured uptake, clearance rate, and the octanol/water partition coefficient for crustaceans. The bioconcentration factor was found to be 5.50, or 1273 on a lipid basis, which is also smaller than values estimated from general relationships. The sediment-to-prawn bioconcentration factor was 0.58, which means that biotic concentrations will be significantly less than those observed in sediments. (Author's abstract)

W91-02042

#### 5C. Effects Of Pollution

##### ASSESSMENT OF CUMULATIVE IMPACTS TO WATER QUALITY IN A FORESTED WETLAND LANDSCAPE.

Clemson Univ., Georgetown, SC. Belle W. Baruch Forest Science Inst.

For primary bibliographic entry see Field 4C.

W91-01017

##### OUTBREAK OF PONTIAC FEVER DUE TO LEGIONELLA ANISA.

Santa Clara County Health Dept., San Jose, CA. M. D. Fensterseib, M. Miller, C. Diggins, S. Liska, and L. Detwiler.

Lancet LANAAL, Vol. 336, No. 8706, p 35-37, July 1990. 1 tab, 8 ref.

Descriptors: \*Aerosols, \*California, \*Human diseases, \*Legionella, \*Public health, \*Water pollution effects, Disinfection, Epidemiology, Infectious diseases, Microbiological studies, Pontiac fever, Water pollution sources, Water treatment.

An outbreak of Pontiac fever occurred among 34 of 56 people attending conferences at a hotel in Santa Clara County, California, in 1988. Two groups had an acute febrile upper respiratory illness, with a mean attack rate of 82% and a mean incubation period of 56 hours. Symptoms resolved spontaneously within 5 days. *Legionella anisa*, which had not previously been associated with outbreaks of Pontiac fever or legionnaires' disease, was isolated from a decorative fountain in the hotel lobby. In addition, 5 of 8 pairs of serum samples from cases showed a more than four-fold rise in antibody titer to the *L. anisa* recovered from the fountain. 42% of the hotel employees had titers greater than or equal to 256 against *L. anisa*, whereas none of 48 serum samples from matched controls had titers greater than or equal to 128. The findings raise concern about water treatment protocols for extent of disease that might be caused by exposure to aerosols containing *L. anisa* and other *Legionella* species. (Author's abstract)

W91-01032

##### MOLYBDENUM AND SULFATE AS CONTROLS ON THE ABUNDANCE OF NITRO-

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

#### GEN-FIXING CYANOBACTERIA IN SALINE LAKES IN ALBERTA.

Cornell Univ., Ithaca, NY. Section of Ecology and Systematics.  
For primary bibliographic entry see Field 2H.  
W91-01034

#### GROWTH AND VOLTINISM OF LOTIC MIDGE LARVAE: PATTERNS ACROSS AN APALACHIAN MOUNTAIN BASIN.

Georgia Univ., Athens. Dept. of Entomology.  
For primary bibliographic entry see Field 2H.  
W91-01038

#### MECHANISM FOR THE HYDROGEN SULFIDE-INDUCED GROWTH LIMITATION IN WETLAND MACROPHYTES.

Louisiana State Univ., Baton Rouge. Center for Wetland Resources.  
For primary bibliographic entry see Field 2H.  
W91-01042

#### GREIGITE AND THE MAGNETIC PROPERTIES OF SEDIMENTS.

Freshwater Biological Association, Ambleside (England). Windermere Lab.  
For primary bibliographic entry see Field 2H.  
W91-01050

#### ALDICARB FOOD POISONINGS IN CALIFORNIA, 1985-1988: TOXICITY ESTIMATES FOR HUMANS.

California Dept. of Health Services, Emeryville. Environmental Epidemiology and Toxicology Branch.  
L. R. Goldman, M. Beller, and R. J. Jackson.  
Archives of Environmental Health AEHLAU, Vol. 45, No. 3, p. May/June 1990. p 141-147, 2 fig, 2 tab, 17 ref.

Descriptors: \*Aldicarb, \*California, \*Public health, \*Toxicity, \*Water pollution effects, Agriculture, Cucumbers, Insecticides, Lethal limit, Watermelon.

Three outbreaks of food poisoning involving watermelons or cucumbers, and caused by the carbamate pesticide aldicarb, occurred in California between 1985 and 1988. For each outbreak, and for an outbreak of aldicarb poisoning associated with English cucumbers previously reported in the literature, dosages of aldicarb sulfide that caused the illness were estimated. Estimated dosages ranged between 0.0011 and 0.06 mg/kg body weight, and most were well below the 0.025 mg/kg Lowest Observed Effect Level (LOEL) for subclinical blood cholinesterase depression previously reported for humans. These findings are consistent with aldicarb sulfide (ASO) illnesses that have occurred in other states. Aldicarb appears to be more toxic than previously suspected. Scientific and regulatory implications are examined. (Author's abstract)  
W91-01052

#### EFFECT OF IRRIGATION WITH SEWAGE EFFLUENT ON DECOMPOSITION OF LITTER IN PINUS RADIATA FORESTS.

New Zealand Forest Service, Rotorua. Forest Research Inst.  
For primary bibliographic entry see Field 3C.  
W91-01067

#### PHYSIOLOGICAL RESPONSE OF YELLOW-POPLAR SEEDLINGS TO SIMULATED ACID RAIN, OZONE FUMIGATION, AND DROUGHT.

Agricultural Research Service, Delaware, OH.  
B. Roberts.  
Forest Ecology and Management FECMDW, Vol. 31, No. 4, p 215-224, April 1990. 2 fig, 1 tab, 25 ref.

Descriptors: \*Acid rain, \*Drought, \*Ozone, \*Poplar trees, \*Seedlings, \*Water pollution effects, Air pollution, Hydrogen ion concentration, Photosynthesis, Plant physiology, Simulation analysis, Water deficit.

One year old containerized seedlings of yellow poplar (*Liriodendron tulipifera* L.) were exposed to simulated acid rain (pH 3.0, 4.0, 5.5), ozone (O<sub>3</sub>) fumigation (0, 0.05, 0.1, 0.2 ppm), and drought (1, 2, or 3 one-week drying cycles) from late May until mid-October. Measurements of net photosynthesis (P), leaf stomatal conductance (G) and xylem water-potential (Z) were made on seedlings from each treatment during June, July and August. Seedlings treated with simulated acid rain at pH 3.0 showed reductions in P (29%), G (33%) and Z (17%) when compared with similar seedlings treated with simulated acid rain with pH 5.5. For seedlings fumigated with ozone, there were no significant differences in P or G between the controls and the other ozone treatments. For seedlings subjected to drought, P increased with increasing stress but Z declined. Interactions involving drought and ozone together had a greater impact on Z than either factor alone. For certain stress combinations, particularly those involving drought, it appears that one factor may exert a dominant role over another in determining the overall physiological response. (Author's abstract)  
W91-01068

#### TOXICOLOGY OF CHEMICAL MIXTURES: EXPERIMENTAL APPROACHES, UNDERLYING CONCEPTS, AND SOME RESULTS.

National Toxicology Program, Research Triangle Park, NC.  
R. S. H. Yang, H. L. Hong, and G. A. Boorman.  
Toxicology Letters TOLED5, Vol. 49, No. 2/3, p 183-197, December 1989. 7 tab, 18 ref.

Descriptors: \*Chemical analysis, \*Toxicology, \*Water pollution effects, Denver, Hazardous wastes, Lake Ontario, Love Canal, New York, Public health, Salmon, Sediment contamination, Waste disposal.

The toxicology of chemical mixtures reflects an actual human exposure situation, yet there is no standard protocol or consensus methodology for investigating the toxicology of mixtures. Thus, experimentation is required just to develop a broadly applicable evaluation system. Several examples are illustrated to present the different experimental designs and the concepts behind each. These include the health effects studies of Love Canal soil samples, the Lake Ontario Coho salmon, the water samples repurified from secondary sewage in the City of Denver Potable Water Reuse Demonstration Plant, and the National Toxicology Program (NTP) effort on a mixture of 25 frequently detected groundwater contaminants derived from hazardous waste disposal sites. In the last instance, an extensive research program has been ongoing for the last two years at the NTP, encompassing general toxicology, biochemical toxicology, myelotoxicology, genetic toxicology, neuro-behavioral toxicology, and hepato-, and renal toxicology. (Lantz-PTT)  
W91-01075

#### HOUSEHOLD EXPOSURE MODELS.

Lawrence Livermore National Lab., CA. Environmental Sciences Div.  
T. E. McKone.  
Toxicology Letters TOLED5, Vol. 49, No. 2/3, p 321-339, December 1989. 1 fig, 7 tab, 25 ref.

Descriptors: \*Drinking water, \*Model studies, \*Volatile organic compounds, \*Water pollution effects, Air pollution, Potable water, Public health.

Human exposure to volatile organic compounds (VOCs) in tap water is often assumed to be dominated by ingestion of drinking water. The relative importance of inhalation and dermal exposure in a typical household was studied using a three-compartment model to simulate the 24-h concentration history of VOCs in the shower, bathroom and remaining household volumes as a result of tap water use. Mass transfers from water to air are derived from measured data for radon and used to estimate mass transfer properties for VOCs. The model is used to calculate a range of concentrations and human exposures in U.S. dwellings. The estimated estimate of household-inhalation uptake to ingestion uptake is in the range of 1-6 for VOCs.

A dermal absorption model is used to assess exposure across the skin boundary during baths and showers. The ratio of dermal exposure to ingestion exposure is in the range of 0.6 to 1. Inhalation of volatile chemicals transported from potable water supplies to indoor air has the potential for being as important as, or more important than, the direct ingestion of these compounds as a route of exposure from potable water supplies. The dermal absorption of chemicals from bath and shower water is based on limited data defining the permeability of the skin to chemical transport. (Lantz-PTT)  
W91-01076

#### STEMMING THE TIDE OF MARINE DEBRIS POLLUTION: PUTTING DOMESTIC AND INTERNATIONAL CONTROL AUTHORITIES TO WORK.

Perkins Coie, Washington, DC.  
For primary bibliographic entry see Field 5G.  
W91-01093

#### EFFECTS OF LAKE ACIDIFICATION ON AQUATIC MACROPHYTES—A REVIEW.

Imperial Coll. at Silwood Park, Sunninghill (England). Dept. of Biology.  
A. M. Farmer.  
Environmental Pollution ENPOEK, Vol. 65, No. 3, p 219-240, 1990. 2 tab, 94 ref.

Descriptors: \*Acid rain effects, \*Aquatic plants, \*Lake acidification, \*Literature review, \*Water pollution effects, Ammonium, Competition, Ecosystems, Hydrogen ion concentration, Macrophytes, Nitrates, Physiological ecology, Plant nutrients, Plant physiology, Species composition.

Acidification of lakes results in a number of chemical, physical and biological changes. With lake acidification, different communities of freshwater macrophytes arise, in response to the pH change. The studies often emphasize the replacement of calcicole species and others such as the isoetids with *Juncus bulbosus* and *Sphagnum* spp. in acidifying lakes. Various alterations in lake conditions affect the physiology of the macrophytes, particularly with changes in the availability of carbon, a change from nitrate to ammonium as a nitrogen source and the effects of an alteration in the lake light climate. It is very unlikely that the responses of one species will be the same in all parts of a lake. The population biology, community ecology and ecosystem functioning of macrophytes show that sometimes competitive processes may seem more important in determining community change than physiological processes. It is important to undertake experimental studies at the correct scale to determine which factors may be causally related to the floristic evidence. (Author's abstract)  
W91-01105

#### INTERACTION BETWEEN COMPONENTS OF ELECTROPLATING INDUSTRY WASTES, INFLUENCE OF THE RECEIVING WATER ON THE TOXICITY OF THE EFFLUENT.

Institut National de la Sante et de la Recherche Medicale, Villeneuve d'Ascq (France). Microbe Ecotoxicology Unit 146.  
A. Le Du, D. Dive, and A. Philippon.  
Environmental Pollution ENPOEK, Vol. 65, No. 3, p 251-267, 1990. 7 fig, 3 tab, 28 ref.

Descriptors: \*Heavy metals, \*Metal-finishing wastes, \*Path of pollutants, \*Stream pollution, \*Synergistic effects, \*Toxicity, \*Water pollution effects, Cadmium, Copper, Dilution, Effluents, Electroplating, Hazard assessment, Mineralization, Nickel, Organic matter, Principal component analysis, Protozoa, Water chemistry, Zinc.

A copper-cadmium-nickel-zinc mixture was assessed in seven different river waters to study metal toxicity to the ciliate protozoan *Colpidium campylum*, the interactions occurring between metals, and the influence of the receiving water on toxicity. In the range of concentrations tested, which is representative of electroplating industry wastes, the main part of the toxicity can be attributed to copper and to copper-cadmium synergy. A

## Effects Of Pollution—Group 5C

classification of waters, based on a principal component analysis (PCA), was used to examine the main parameters of the water, which can affect the toxicity of metal mixtures. The mineralization of the water, more than the total organic matter, appears to be an important parameter for the expression of toxicity. A strategy for the estimation of ecotoxicological hazard assessment, based upon a simplified factorial experiment enables the study of the toxicity of an effluent, the influence of river water on its toxicity, and the effects of contact time and dilution in a two-step bioassay. By applying PCA to data from very different waters, it may be possible to estimate the ecotoxicological risk associated with the discharge of an effluent, on the basis of the chemistry of the receiving water. (Author's abstract)  
W91-01106

## GREEN OYSTERS CAUSED BY COPPER POLLUTION ON THE TAIWAN COAST.

National Taiwan Univ., Taipei. Inst. of Oceanography.  
B. Han, and T. Hung.  
Environmental Pollution ENPOEK, Vol. 65, No. 4, p 347-362, 1990. 4 fig, 6 tab, 35 ref.

Descriptors: \*Bioaccumulation, \*Copper, \*Oysters, \*Path of pollutants, \*Taiwan, \*Water pollution effects, \*Aquaculture, Heavy metals, Marine pollution, Shellfish.

The first case of green oysters (*Crassostrea gigas*) broke out along the Charting mariculture area of southwestern Taiwan in January, 1986. The green color was found to be due to high copper content in the oyster tissue. Since then, a long-term survey around this area shows that total dissolved copper ranges from 4.99 to 23.6 microg/L and particulate copper ranges from 1.09 to 5.51 microg/L in sea water. The green oysters collected from the Erjhi Chi estuary on January 26, 1989 gave the highest copper content, 4401 plus or minus 79 ppm dry weight. Other green oyster cases were occasionally observed in the Hsiangsan and Anpin mariculture areas. Meanwhile, an experiment of copper accumulation in oysters was conducted at three stations (southwestern Taiwan) for up to 90 days. Multiple regression analysis indicates that the food pathway may predominate in copper accumulation by green oysters. This bioaccumulation experiment shows that the total uptake of copper per oyster is an exponential function of exposure time for the first two weeks with an accumulation rate of 214 ppm copper/day and then levels off. The average values of concentration factors for oysters (about 500,000) were very close to steady-state values under the natural conditions at each station. (Author's abstract)  
W91-01108

## EFFECTS OF ACIDIC IRRIGATION ON SOIL MICROORGANISMS AT KEVO, NORTHERN FINLAND.

Turku Univ. (Finland). Dept. of Biology.  
M. Kytöviita, H. Fritze, and S. Neuvonen.  
Environmental Pollution ENPOEK, Vol. 66, No. 1, p 21-31, 1990. 1 fig, 4 tab, 26 ref.

Descriptors: \*Acid rain effects, \*Finland, \*Simulated rainfall, \*Soil organics, \*Water pollution effects, Acid rain, Bacterial physiology, Litter, Microorganisms, Soil bacteria, Soil fungi.

Increasing rates of pollution in the northern hemisphere have led to a large number of studies concerning different aspects of acidification. Effects of simulated acid rain (a mixture of sulfuric acid and nitric acid; pH 3) on soil microbiology were studied in a field experiment in northern Finland. Irrigated control plots received the same amount of spring water (pH 6) as the acid treated plots. Fungal lengths and total bacterial numbers were studied after the treatments had continued for three growing seasons. The numbers of bacteria in five physiological groups (those utilizing starch, protein, pectin, xylan, or cellulose) were measured by most probable number (MPN) techniques. The lengths of total and FDA stained fungal hyphae were not significantly different between the acid treated and the control plots. The counts of total

bacteria were not significantly different between treatments, but the MPNs of all five physiological groups of bacteria were approximately 60% lower in the acid treated plots than in the controls. The results of the present study suggest that changes in soil microbial activity caused by moderate acidification may be important in a long term perspective and a reduction in the amounts of bacteria utilizing cellulose, starch, pectin, xylan and protein may at least partially explain the lower mass loss of litter on acid treated soils. (Brunone-PTT)  
W91-01109

## BIOACCUMULATION AND TOXICITY OF ZINC IN THE GREEN ALGA, CLADOPHORA GLOMERATA.

Polytechnic of Central London (England). Applied Ecology Research Group.  
B. M. McHardy, and J. J. George.  
Environmental Pollution ENPOEK, Vol. 66, No. 1, p 55-66, 1990. 4 fig, 2 tab, 24 ref.

Descriptors: \*Algae, \*Bioaccumulation, \*Chlorophyta, \*Toxicity, \*Water pollution effects, \*Zinc, Algal growth, Aquatic plants, England, Path of pollutants, Plant physiology.

The bioaccumulation and toxicity of zinc in *Cladophora glomerata* from two populations in the River Roding, Essex, UK, were examined in experimental laboratory flowing-water channels. Plants were subjected to concentrations ranging from 0 to 4.0 mg/L at current velocities of 20 to 33 cm/sec for up to three hours. Zinc in algal tissue was then quantified and toxicity was assessed by the ability of the alga to grow in a recovery medium after the experimental treatment. There was little difference in zinc bioaccumulation between *Cladophora* from the site showing mild organic pollution and that from the site subjected to considerable inputs from urban and motorway runoff. Uptake of zinc increased with increasing concentration in the test solution and was linear and proportional up to 0.4 mg/L. Three stages of uptake were identified with the most dramatic accumulation occurring in the first ten minutes. Experimental concentration factors ranged from 1900 to 5200, which were in agreement with those previously obtained in the field. Cellular damage was evident in *Cladophora* subjected to 0.4 mg/L zinc and this increased with increasing zinc concentration, thus leading to the conclusion that, at times, the levels of zinc found in the river could be potentially damaging. (Author's abstract)  
W91-01111

## MOLLUSC THAIS HAEMASTOMA - AN EXHIBITOR OF 'IMPOSEX' AND POTENTIAL BIOLOGICAL INDICATOR OF TRIBUTYL TIN POLLUTION.

Liverpool Univ., Port Erin (England). Dept. of Marine Biology.  
S. K. Spence, S. J. Hawkins, and R. S. Santos.  
Marine Ecology (PSZNI) MAECOR, Vol. 11, No. 2, p 147-156, 1990. 5 fig, 1 tab, 22 ref.

Descriptors: \*Antifoulants, \*Bioindicators, \*Gastropods, \*Imposex, \*Mollusks, \*Organotin compounds, \*Water pollution effects, Animal physiology, Aquatic animals, Azores, Bioaccumulation, Marine pollution, Tributyltin.

In the Azores, the gastropod *Thais haemastoma* shows varying degrees of imposex, the induction of male sex characters in the female. It is inferred that imposex in *T. haemastoma* is caused by tributyltin (TBT) associated with boats using organotin-based antifoulant paints. The two indices (relative penis size and vas deferens sequence) employed previously for *Nucella lapillus*, were used without alteration. *T. haemastoma* is only the third species reported as exhibiting 'effective sterilization' of the female. Unlike *N. lapillus*, *T. haemastoma* has a planktonic larva, allowing populations to be sustained even when local TBT pollution is high. This makes *T. haemastoma* potentially a better indicator species, as monitored populations can be maintained by the influx of larvae. *T. haemastoma* may thus provide a cheap method of assessing the extent of TBT contamination in warm waters, particularly in the Mediterranean and Atlantic Islands.

Preliminary examination of material from a marina in Spain showed a high incidence of 'sterile' animals. (Author's abstract)  
W91-01118

## COMPARISON OF THE ACIDIFICATION EFFICIENCIES OF NITRIC AND SULFURIC ACIDS BY TWO WHOLE-LAKE ADDITION EXPERIMENTS.

Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.  
For primary bibliographic entry see Field 5B.  
W91-01143

## EPIPHYTIC ALKALINE PHOSPHATASE ON NATURAL AND ARTIFICIAL PLANTS IN AN OLIGOTROPHIC LAKE: RE-EVALUATION OF THE ROLE OF MACROPHYTES AS A PHOSPHORUS SOURCE FOR EPIPHYTES.

North Carolina State Univ. at Raleigh. Dept. of Botany.  
For primary bibliographic entry see Field 2H.  
W91-01146

## EFFECT OF MERCURY AND SELENIUM ON THE GILL FUNCTION OF MYTILUS EDULIS.

University Coll. of Swansea (Wales). Dept. of Earth Sciences.  
S. Micallef, and P. A. Tyler.  
Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 6, p 288-292, June 1990. 2 fig, 1 tab, 34 ref.

Descriptors: \*Bioindicators, \*Mercury, \*Mussels, \*Selenium, \*Water pollution effects, Gills, Heavy metals, Marine pollution, Mytilus, Toxicity.

The effect of selenium and mercury on the filtration, oxygen consumption, and associated processes of ciliary activity of *Mytilus edulis* was studied. Mussels were exposed to mercury (50 microgram Hg/L) and selenium (50 microgram Se/L) or to a combination of mercury (50 microgram Hg/L) and selenium in an equimolar (50 microgram Se/L) or an equimolar (19.7 microgram Se/L) ratio for 120 hours. The filtration rate in mussels exposed to mercury and combined treatments was severely affected within 2 hours. Mussels exposed to selenium showed a reduced filtration rate intermediate between the controls and the other treatments. The effect of the individual and combined treatments on ciliary activity was transient, while the effect on oxygen consumption was not significant. Under these laboratory conditions selenium in its reduced chemical form failed to protect mussels against mercury toxicity. (Author's abstract)  
W91-01159

## BIOFILM CHARACTERISTICS IN COASTAL WATERS OF BOMBAY.

Naval Chemical and Metallurgical Lab., Bombay (India).  
For primary bibliographic entry see Field 2L.  
W91-01170

## RECOVERY OF 3-CHLORO-4-(DICHLORO-METHYL)-5-HYDROXY-2(5H)-FURANONE FROM WATER SAMPLES ON XAD RESINS AND THE EFFECT OF CHLORINE ON ITS MUTAGENICITY.

Health Effects Research Lab., Research Triangle Park, NC. Genetic Toxicology Div.  
For primary bibliographic entry see Field 5A.  
W91-01181

## WATERSHED 89: THE FUTURE FOR WATER QUALITY IN EUROPE, VOLUME II.

For primary bibliographic entry see Field 5G.  
W91-01211

## WATER QUALITY EVALUATION IN LAKES OF GREECE.

National Centre for Marine Research, Athens (Greece).  
For primary bibliographic entry see Field 2H.  
W91-01212

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

#### IS IT POSSIBLE TO REGAIN AN ECOLOGICAL BALANCE IN A LAKE WITH BLOOMS OF NUISANCE MICROORGANISMS.

National Inst. of Public Health, Oslo (Norway).  
Dept. of Water and Hygiene.  
H. C. Utikilen.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 205-209, 3 fig, 1 tab, 12 ref.

Descriptors: \*Algal blooms, \*Cyanophyta, \*Eutrophication, \*Lake restoration, \*Phosphorus, \*Water pollution control, \*Water pollution treatment, Algal growth, Aquatic bacteria.

Cyanobacteria (blue-green algae) blooms can cause several problems in a water source, rendering it less suitable for drinking or recreational purposes. Such problems occurred in the Norwegian lake Mjøsa, where a bloom of *Oscillatoria borealis* f. *tenuis* produced the off-flavor component geosmin. This resulted in an attempt to stop and reverse the ongoing eutrophication by decreasing the phosphorus loading to the lake. The plan which included building new sewage treatment plants, banning the use of phosphorus-containing detergents, and reducing agricultural runoff to the lake was initiated in 1976 and lasted until 1981. During this period the theoretical phosphorus loading of the lake was reduced from 380 ton/yr to 220 ton/yr. From 1979, the cyanobacteria level was negligible. However, after 1981 the phosphorus concentration in the lake increased again and larger amounts of cyanobacteria causing problems reappeared. The experience from lake Mjøsa therefore shows that it is possible to stop and even reverse eutrophication, but the effort to reverse pollution has to be an ongoing process. (See also W91-01211) (Author's abstract)

W91-01220

#### CYANOBACTERIAL TOXINS IN EUROPEAN WATERS: OCCURRENCE, PROPERTIES, PROBLEMS AND REQUIREMENTS.

Dundee Univ. (Scotland). Dept. of Biological Sciences.

For primary bibliographic entry see Field 5B.  
W91-01221

#### WELL-WATER METHAEMOGLOBINAEMIA: THE BACTERIAL FACTOR.

Norsk Hydro, Porsgrunn. Research Centre.  
O. C. Cockman, and D. D. Bryson.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 239-244, 15 ref.

Descriptors: \*Drinking water, \*Enteric bacteria, \*Human diseases, \*Nitrites, \*Public health, \*Water pollution effects, \*Well water, *Escherichia coli*, Nitrites, Potable water, Water pollution sources.

Excessive amounts of nitrate in drinking water are assumed to increase the risk of infant well-water methemoglobinemia. Recent research suggests that methemoglobinemia is a very rare and disappearing disease in young bottle-fed infants. Methemoglobinemia is multifactorial in origin, and although the relative importance of each causal factor has not been studied, it is associated with the use of water from private wells. The condition is linked with nitrate in water through clinical association. Since enteritis can also cause methemoglobinemia, the elimination of nitrate from drinking water cannot totally prevent outbreaks of methemoglobinemia. Effective prevention criteria should also stress water microbial purity. There is strong evidence that potable water with 50 mg NO<sub>3</sub><sup>-</sup>/L is safe. Experience also indicates that potable water with up to 100 mg/NO<sub>3</sub><sup>-</sup>/L is also safe. (See also W91-01211) (Author's abstract)

W91-01224

#### NECESSITY OF BIOASSAYS IN WATER QUALITY MONITORING.

Institut fuer Wasserforschung G.m.b.H. Dortmund, Schwerte (Germany, F.R.).

For primary bibliographic entry see Field 5A.

W91-01225

#### INTERFACE OF HEALTH EFFECTS AND CHEMISTRY AT WATER TREATMENT PLANTS.

Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).

For primary bibliographic entry see Field 5F.  
W91-01226

#### MICROPOLLUTANTS IN WATER USED FOR RENAL DIALYSIS: AN INTERNATIONAL PERSPECTIVE.

Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.

S. Bragg, S. J. Sollars, and R. Perry.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 265-276, 1 fig, 10 tab, 41 ref.

Descriptors: \*Aluminum, \*Dialysis, \*Disinfection, \*Public health, \*Renal dialysis, \*Water pollution effects, \*Water treatment, Bacteria, Calcium, Copper, Fluorides, Lead, Magnesium, Membrane processes, Nitrites, Organic compounds, Sulfates, Trace elements, Trace metals, Water pollution prevention, Zinc.

With the number of renal dialysis patients increasing in Europe and North America, the full importance of the quality of the water used for renal dialysis is being recognized. Aluminum intoxication in dialysis patients, first described in the early 1970's, highlighted the need for adequate treatment of water used to prepare dialysate. Other potential contaminants include calcium, magnesium, copper, lead, zinc, fluorides, sulfate, nitrate, chloramines, organic materials, and bacteria. Some of these, e.g. chloramines, may arise as a result of water treatment practice, while others, such as trace organic materials, are increasingly present in the environment and may not be completely removed at the water treatment stage. Use of aluminum sulfate as a coagulant in water treatment may be a source of high aluminum contents in dialysis water. Chloramines, chloroform, and other halogenated alkyls may be generated when chlorine is used for water disinfection. Bacterial growth may occur in water distribution systems, particularly if there are stagnant sections. Water softeners, sediment filters, carbon filters, reverse osmosis and deionizers are used in purifying dialysis water. Standards have been set by the European and American communities for the levels of trace compounds and elements permissible in dialysis water based on extensive research studies. Although monitoring trace impurities in dialysis water and the blood of dialysis patients may add up to 10% of the total cost of renal dialysis, such an investment might, in the long run, reduce overall costs of health care for dialysis patients. (See also W91-01211) (Geiger-PTT)

W91-01227

#### COMPLEXITY, ENTROPY AND ENVIRONMENTAL EFFECT.

Queen Mary Coll., London (England). School of Biological Sciences.

P. Johnston, and R. Stringer.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 283-291, 4 fig, 24 ref.

Descriptors: \*Entropy, \*Environmental effects, \*Toxicity, \*Toxicology, \*Water pollution effects, Cleanup, Daphnia, England, Evaluation, Selenium.

The identification of an ecotoxicological problem usually occurs after the scope of the problem has become too wide to address in simple remedial terms. After a potential toxicological effect has been identified for a material then a wide evaluation generally follows. This causes a delay between

the time a pollutant is identified and the time action is taken to eliminate it. The data generated to evaluate the toxic effects of inorganic selenium on *Daphnia magna* illustrates the time consuming process of a toxicological evaluation. Conceptual evaluations show that human use of energy will inevitably be associated with environmental degradation which can be regarded as an increase in entropy. Anthropogenically mobilized contaminants tend not to become evenly distributed throughout the environment as assumed by dischargers. Instead they selectively partition into environmental or biological compartments with which they have an affinity as a result of free energy considerations, or undergo entropy decreases as a result of biological energy input. Given the inability to predict the degree to which an ecosystem will be compromised by interaction with any given contaminant or to evaluate the degree of compromise once it has been established, dischargers of any materials to the wider environment should consider the precautionary principle axiomatic to the formulation of environmental legislation. (See also W91-01211) (Geiger-PTT)

W91-01229

#### TOXICITY OF WATER EXTRACTS OF HAZARDOUS WASTE.

Wyższa Szkoła Inżynierska, Zielona Góra (Poland).

E. S. Kempa, A. Jedrczak, M. Piontek, and A. Solski.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 297-305, 4 fig, 2 tab, 9 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Hazardous wastes, \*Industrial wastes, \*Sludge, \*Toxicity, \*Water pollution effects, Aquatic plants, Cadmium, Chromium, Copper, Daphnia, Heavy metals, Metal-finishing wastes.

The toxicity of industrial wastes is measured by the content of noxious, chemically active substances and particularly by their solubility in water. The chemical composition of the water extracts does not fully reflect their noxious impact on the organisms living in the freshwater ecosystems. At improperly protected landfills, leachates often penetrate onto the aquifers causing pollution or even contamination of surface water and groundwater resources. Forty industrial solid wastes and sludges and their water extracts were analyzed for their toxicity to *Lemna minor* L., *Daphnia magna* Straus, and *Dugesia tigrina* Girard. A considerable differentiation in toxicity was observed. The most toxic turned out to be three electroplating sludges containing top limiting concentrations of heavy metals (cadmium, copper, and chromium). The animal organisms, especially *Daphnia magna*, were more sensitive to the water extracts of the tested wastes. The toxicity of sludges and wastes was expressed by the degree of water extracts: Group I, extremely toxic wastes (dilution < 1%), Group II, hazardous wastes (dilution from 1 to 10%), Group III, wastes of low toxicity (dilution from 10 to 100%), and Group IV, non-toxic wastes. (See also W91-01211) (Geiger-PTT)

W91-01231

#### COPPER TOXICITY TO PARATYA AUSTRALIENSIS: I. INFLUENCE OF NITRILOTRIACETIC ACID AND GLYCINE.

Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.

H. R. Daly, I. C. Campbell, and B. T. Hart.

Environmental Toxicology and Chemistry  
ETOCCK, Vol. 9, No. 8, p 997-1006, August 1990.  
5 tab, 2 fig, 40 ref.

Descriptors: \*Amino acids, \*Chemical speciation, \*Copper, \*Ion-selective electrodes, \*Metal complexes, \*Nitrilotriacetic acid, \*Shrimp, \*Toxicity, \*Toxicology, \*Water pollution effects, Bioassay, Heavy metals, Lethal limit, Mortality.

It is now widely accepted that the toxicity, bioavailability, and transport of heavy metals in aquatic

## Effects Of Pollution—Group 5C

systems are dependent upon the physicochemical forms, or speciation, of the particular metal. The relationship between copper speciation and acute toxicity to the Australian freshwater shrimp, *Paratya australiensis* was determined using a combination of copper ion selective electrode measurements, complexing resins and computer calculations to measure the speciation in test solutions. 48 hour LC50 values for *P. australiensis* exposed to copper in Melbourne tap water were 43 micrograms Cu/L (total copper) and 22 micrograms Cu/L (measured for Cu(II) ion). With a 1 micromolar concentration of NTA the 48 hour values were 109 and 23 micrograms Cu/L (calculated), respectively, and for 20 micromolar glycine solutions the values were 130 and 39 micrograms Cu/L (measured), respectively. A number of problems were encountered with the use of the copper ion selective electrode in waters containing added complexing agents. In solutions containing nitritolactic acid or glycine, uncomplexed copper(II) ions were found to be the most acutely toxic form of copper to the shrimp. However, at least one other species, the singly charged complex (Cu-Glycine)(+), also appears to be mildly toxic. The results of this study demonstrate the importance of considering metal speciation when assessing the impact of heavy metals on aquatic organisms. (See also W91-01259 and W91-01260) (Author's abstract) W91-01258

#### COPPER TOXICITY TO PARATYA AUSTRALIENSIS: II. INFLUENCE OF BICARBONATE AND IONIC STRENGTH.

Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.  
H. R. Day, I. C. Campbell, and B. T. Hart.  
Environmental Toxicology and Chemistry  
ETOC DK, Vol. 9, No. 8, p 1007-1011, August 1990. 1 fig, 3 tab, 22 ref.

Descriptors: \*Bicarbonates, \*Chemical speciation, \*Copper, \*Ionic interference, \*Metal complexes, \*Shrimp, \*Sodium chloride, \*Toxicity, \*Toxicology, \*Water pollution effects, Alkaline water, Bioassay, Cations, Heavy metals, Ion-selective electrodes, Lethal limit, Mortality.

Experiments were conducted as part of a study on the relationship between the physicochemical forms of copper and its toxicity to the Australian freshwater shrimp, *Paratya australiensis*. The acute toxicity of copper to *P. australiensis* was shown to decrease in solutions of increasing alkalinity brought about by the addition of sodium bicarbonate, NaHCO<sub>3</sub>. This effect could not be explained merely in terms of changes in copper speciation in the solutions. Estimates of the free copper(II) ion concentration of the LC50 values were made using both copper ion selective electrode measurements and chemical equilibrium computer calculations. Whereas there were discrepancies between the estimates obtained using these methods, both indicated an apparent increase in tolerance of *P. australiensis* to the free copper (II) ion in more alkaline waters. An additional set of experiments, in which sodium chloride was added to test waters in place of sodium bicarbonate, demonstrated that the increased tolerance of *P. australiensis* to copper in higher alkalinity waters was caused by a combination of physiological effects associated with increased ionic strength of the test waters and, to a lesser extent, changes in metal speciation in test waters. (See also W91-01258 and W91-01260) (Author's abstract) W91-01259

#### COPPER TOXICITY TO PARATYA AUSTRALIENSIS: III. INFLUENCE OF DISSOLVED ORGANIC MATTER.

Chisholm Inst. of Tech., Melbourne (Australia). Center for Stream Ecology.  
H. R. Day, M. J. Jones, B. T. Hart, and I. C. Campbell.  
Environmental Toxicology and Chemistry  
ETOC DK, Vol. 9, No. 8, p 1013-1018, August 1990. 1 fig, 3 tab, 22 ref.

Descriptors: \*Chemical speciation, \*Copper, \*Dissolved solids, \*Metal complexes, \*Shrimp, \*Toxicity, \*Toxicology, Bioassay, Heavy metals, Ion-se-

lective electrodes, Lethal limit, Mortality, Natural waters.

Experiments were conducted as part of a study on the relationship between the physicochemical forms of copper and its toxicity to the Australian freshwater shrimp, *Paratya australiensis*. The influence of dissolved organic matter on the toxicity of copper to *P. australiensis* was measured using water collected from three sites in Victoria, Australia. A two-ligand model was used to describe copper complexation in these test waters. The binding characteristics of the ligands (i.e., total ligand concentrations and conditional stability constants) were determined using a method combining ion selective electrode and anodic stripping voltammetry. Ion selective measurements and the two-ligand model were each used to estimate the concentration of copper(II) (the major toxic species) at the LC50 values. Both methods overestimated by a factor of approximately 1.5 to 3 the expected copper(II) concentration at the LC50 values, based on earlier experiments in Melbourne tap water. The agreement seems remarkably good given the many assumptions used in making the comparison and the difficulties encountered with the use of ion selective electrodes in natural waters. (See also W91-01258 and W91-01259) (Author's abstract) W91-01260

#### COMPARISON OF MEASURED INSTREAM BIOLOGICAL RESPONSES WITH RESPONSES PREDICTED USING THE CERIODAPHNIA DUBIA CHRONIC TOXICITY TEST.

North Carolina Dept. of Natural Resources and Community Development, Raleigh. Div. of Environmental Management.  
K. W. Eagleson, D. L. Lenat, L. W. Ausley, and F. B. Winborne.  
Environmental Toxicology and Chemistry  
ETOC DK, Vol. 9, No. 8, p 1019-1028, August 1990. 1 fig, 1 tab, 26 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Daphnia, \*Effluents, \*Model testing, \*Toxicity, \*Toxicology, \*Water pollution effects, Chronic toxicity, Data collections, Industrial wastewater, Mortality, Municipal wastewater, North Carolina, Stream pollution, Wastewater disposal, Water quality standards.

Regulation of surface water discharge of toxic substances through the use of whole effluent toxicity testing is being used with increasing frequency for state and federal programs. In this study, instream toxicity was predicted with whole effluent toxicity tests. These results were then compared to the observed instream response of the aquatic community. Forty-three comparisons were conducted in freshwater flowing systems using *Ceriodaphnia dubia* chronic toxicity test procedures and standardized qualitative sampling of benthic macroinvertebrates. In 88% of the comparisons there was agreement between both measures. These data suggest that the use of effluent toxicity testing results as a regulatory tool is effective and appropriate. Comparisons used whole effluent toxicity limitations similar to those being written in North Carolina's NPDES permits for discharge to surface waters. (Author's abstract) W91-01261

#### EFFECT OF SEDIMENT SPATIAL VARIANCE AND COLLECTION METHOD ON CLADOCERAN TOXICITY AND INDIGENOUS MICROBIAL ACTIVITY DETERMINATIONS.

Wright State Univ., Dayton, OH. Dept. of Biological Sciences.  
For primary bibliographic entry see Field 5A.  
W91-01262

#### ACUTE TOXICITIES OF FIVE SYNTHETIC PYRETHROID INSECTICIDES TO DAPHNIA MAGNA AND CERIODAPHNIA DUBIA.

Texas Christian Univ., Fort Worth. Dept. of Biology.  
L. E. Mokry, and K. D. Hoagland.  
Environmental Toxicology and Chemistry  
ETOC DK, Vol. 9, No. 8, p 1045-1051, August

1990. 4 tab, 25 ref.

Descriptors: \*Daphnia, \*Insecticides, \*Permethrin, \*Pesticide toxicity, \*Pyrethroids, \*Toxicity, \*Toxicology, \*Water pollution effects, Bioassay, Median tolerance limit, Mortality.

The acute toxicities of four recently developed pyrethroid insecticides (bifenthrin, cyfluthrin, lambda cyhalothrin and tralomethrin) were experimentally compared to the acute toxicity of a first generation pyrethroid (permethrin), in static-flow, 48-hour bioassays with *Daphnia magna* and *Ceriodaphnia dubia*. The four new generation pyrethroids exhibited greater toxicity in comparison to permethrin, which had 48 hour LC50s of 1.25 micrograms/L for *D. magna* and 0.55 micrograms/L for *C. dubia*. LC50s for *D. magna* and *C. dubia* were 0.32 and 0.07 for bifenthrin, 0.17 and 0.14 for cyfluthrin, 1.04 and 0.30 for lambda cyhalothrin, and 0.15 and 0.26 micrograms/L for tralomethrin, respectively. Tralomethrin and cyfluthrin were most toxic to *D. magna*, and *C. dubia* was equally or more sensitive to *D. magna* to all of the insecticides. This indicates higher biological activity of the newer pyrethroids than permethrin to nontarget organisms. (VerNooy-PTT) W91-01263

#### YOLK RETINOLIDS (VITAMIN A) IN EGGS OF THE HERRING GULL AND CORRELATIONS WITH POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS.

Ottawa Univ. (Ontario). Dept. of Biology.  
P. A. Spear, D. H. Bourbonnais, R. J. Norstrom, and T. W. Moon.  
Environmental Toxicology and Chemistry  
ETOC DK, Vol. 9, No. 8, p 1053-1061, August 1990. 3 fig, 3 tab, 36 ref.

Descriptors: \*Bioindicators, \*Birds, \*Dioxins, \*Eggs, \*Gulls, \*Polychlorinated biphenyls, \*Polycyclic aromatic hydrocarbons, \*Teratogenic effects, \*Toxicology, \*Vitamins, \*Water pollution effects, Correlation analysis, Great Lakes, High performance liquid chromatography, Monitoring.

Little is known of the combined effects associated with chronic, low-level exposure of wildlife to the polyhalogenated dibenzo-p-dioxins (PCDDs for chlorinated compounds), dibenzofurans (PCDFs), certain biphenyls and other related compounds. To examine possible effects upon egg yolk retinoids, herring gull (*Larus argentatus*) eggs were collected at early (i.e., days 2-12) and late (i.e., approximately day 20) phases of incubation. Analysis of egg yolks by reversed-phase high-performance liquid chromatography revealed compounds that comigrated with all-trans-retinyl palmitate standards. The retinol concentration and the molar ratio of retinol to retinyl palmitate changed significantly between the early and late phases of incubation. Within the 2 to 12 day period of incubation, however, retinoid values were constant. Gull eggs were collected from two breeding colonies on the Great Lakes in 1986 and from five colonies in 1987. In 2 to 12 day eggs, retinol and retinyl palmitate concentrations were significantly different between colonies. The molar ratio of retinol to retinyl palmitate was significantly different between colonies and correlated with several indices of polychlorinated dibenzo-p-dioxin and dibenzofuran concentrations quantified in gull eggs from these collection sites. Significant correlations existed between the molar ratio of retinoids and 2,3,7,8-tetrachloro-dibenzodioxin (TCDD), toxic equivalents of PCDDs and PCDFs and the sum of PCDD and PCDF concentrations. These results, and data from a previous study of vitamin A stores support the hypothesis that chlorinated dioxins and possibly other contaminants are affecting the vitamin A status of wild birds. Changes in yolk retinoids may prove to be an early indicator of such effects as embryo mortality and teratogenesis of the type currently observed in Great Lakes birds. (Author's abstract) W91-01264

#### TOXICITY OF FLUORANTHENE IN SEDIMENT TO MARINE AMPHIPODS: A TEST OF

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

#### THE EQUILIBRIUM PARTITIONING APPROACH TO SEDIMENT QUALITY CRITERIA

Environmental Research Lab-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.  
R. C. Swartz, D. W. Schults, T. H. Dewitt, G. R. Ditsworth, and J. O. Lamberson.  
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 8, p 1071-1080, August 1990. 5 fig, 4 tab, 33 ref. EPA Agreement CX812-792-01-0.

Descriptors: \*Amphipods, \*Bioassay, \*Fluoranthene, \*Marine pollution, \*Polycyclic aromatic hydrocarbons, \*Sediment contamination, \*Toxicity, \*Toxicology, \*Water pollution effects, Environmental quality, Equilibrium, Interstitial water, Model studies, Mortality, Path of pollutants, Population exposure.

The toxicity to the marine benthic amphipods, *Rhepoxynius abronius* and *Corophium spicorne*, of fluoranthene in sediment was determined in relation to the equilibrium partitioning (EP) approach to the development of sediment quality criteria. Toxicity tests were conducted with well-sorted fine sands at three levels of organic carbon (OC), 0.18, 0.31, and 0.48%. Measured interstitial water concentrations of fluoranthene less than 50 microg/L were highly correlated with predictions based on the EP model. LC50s based on total fluoranthene concentrations increased significantly with increasing sediment OC. LC50s based on fluoranthene concentration in interstitial water were not significantly different between 0.18 and 0.48% OC or between 0.31 and 0.48%, but the LC50 at 0.31% was significantly higher than that at 0.18% OC. The regression of sediment OC on bulk fluoranthene LC50 was linear, indicating that the concentration of fluoranthene in interstitial water was constant at equilibrium conditions, as predicted by the EP model. The 10-day LC50 of fluoranthene in interstitial water (23.8 microg/L) was intermediate between the acute (40 microg/L) and chronic (16 microg/L) EPA water quality standards for fluoranthene. The epibenthic, tube-dwelling *Corophium* was less sensitive to test sediments than the infaunal, free-borrowing *Rhepoxynius*, possibly because of different routes of exposure to fluoranthene. There was a close correspondence between estimates of sediment quality for fluoranthene based on distinctly different methodologies including EP, apparent effects threshold, toxicity tests applied to experimentally spiked sediment and toxicity tests applied to field-collected sediment. (Author's abstract)  
W91-01265

#### ASSESSMENT OF THE ONTARIO MINISTRY OF THE ENVIRONMENT PROTOCOLS FOR CONDUCTING DAPHNIA MAGNA ACUTE LETHAL TOXICITY TESTS WITH PULP AND PAPER MILL EFFLUENTS

Pulp and Paper Research Inst. of Canada, Pointe Claire (Quebec).  
T. G. Kovacs, and S. M. Ferguson.  
Environmental Toxicology and Chemistry ETOCDK, Vol. 9, No. 8, p 1081-1093, August 1990. 3 fig, 9 tab, 36 ref.

Descriptors: \*Bioassay, \*Daphnia, \*Laboratory methods, \*Pulp and paper industry, \*Quality control, \*Toxicity, \*Toxicology, \*Water pollution effects, Canada, Effluents, Mortality, Performance evaluation, Testing procedures, Variation coefficient, Water quality standards.

The Ontario Ministry of the Environment protocols for conducting *Daphnia magna* acute lethal toxicity tests were evaluated for pulp and paper mill effluents. The evaluation included an interlaboratory study and an intralaboratory assessment using different dilution waters, test containers and pH adjustment. When the tests were conducted under similar conditions, the results (i.e., 48-hour LC50s) from four participating laboratories were similar. With one exception, the coefficients of variation for interlaboratory testing ranged from 3.0 to 17%. However, within a laboratory, the ratio of the highest to lowest LC50 values for a particular effluent ranged from 1.9 to 3.8 when

using different dilution waters and ranged from 1.3 to 1.9 when the test solution pH was adjusted to the same level as the dilution water pH. The *D. magna* were found to be 1.5 to 4.0 times less sensitive than rainbow trout and 1.6 to 3.0 times less sensitive than *Ceriodaphnia affinis* to pulp and paper mill effluents, and dehydroabietic acid. (Author's abstract)  
W91-01266

#### EUTROPHICATION: ASSESSMENT, RESEARCH AND MANAGEMENT WITH SPECIAL REFERENCE TO SCOTLAND'S FRESH WATERS

Institute of Terrestrial Ecology, Edinburgh (Scotland).  
A. E. Bailey-Watts.  
Journal of the Institution of Water and Environmental Management JIWMEEZ, Vol. 4, No. 3, p 285-294, June 1990. 6 fig, 86 ref.

Descriptors: \*Algal growth, \*Eutrophication, \*Limnology, \*Literature review, \*Nutrient concentrations, \*Scotland, \*Water quality management, Algal blooms, Freshwater, Nitrogen, Phosphorus, Pollution load, Research, Water quality control.

In response to the extraordinarily high profile currently maintained by algae, aspects of pure and applied research on eutrophication were investigated. In addition to restating a number of issues which were raised decades ago when the importance of this environmental problem was first recognized, the following aspects are explored using data collected mainly over the last 20 years and referring primarily to Scottish studies: (i) algal-nutrient relations and the contrasting manner in which nitrogen and phosphorus enter freshwaters and are sequestered by planktonic organisms; (ii) estimates of the loadings of phosphorus to freshwaters from various sources; (iii) the effects on the perception of algal problems and the use to which the waters are intended; (iv) the extent and limitations of existing scientific knowledge about eutrophication, and its application to the formulation and execution of eutrophication control strategies; and (v) the arguments for maintaining in-depth limnological surveillance programs. (Author's abstract)  
W91-01277

#### APPRAISAL OF THE POTENTIAL HEALTH IMPACTS OF SEWAGE DISPOSAL TO UK COASTAL WATERS

Saint David's Univ. Coll., Lampeter (Wales).  
Centre for Research into Environment and Health.  
For primary bibliographic entry see Field 5B.  
W91-01278

#### INTERACTION OF CARBON TETRACHLORIDE WITH BETA-NAPHTHOFLOAVONE-MEDIATED CYTOCHROME P450 INDUCTION IN WINTER FLOUNDER (PSEUDOPLEURONectes AMERICANUS)

Louisiana State Univ., Baton Rouge. School of Veterinary Medicine.  
K. M. Kleinow, B. F. Droy, D. R. Buhler, and D. E. Williams.  
Toxicology and Applied Pharmacology TXAPA9, Vol. 104, No. 2, p 365-374, June 15, 1990. 3 fig, 1 tab, 25 ref. Mount Desert Island Biological Laboratory-Marine and Freshwater Biomedical Sciences Specialized Research Center Grant EHA 1 P30 ES03828-02.

Descriptors: \*Bioassay, \*Chlorinated hydrocarbons, \*Cytochromes, \*Fish physiology, \*Flounders, \*Naphthoflavone, \*Toxicity, Animal tissues, Biochemical tests, Histology, Immunology, Liver, Sublethal effects, Tissue analysis.

Cytochrome P450-dependent activity in fish has been shown to be induced by exposure to low levels of environmental pollutants. This response to environmental xenobiotics has focused attention upon P450 induction as a possible biological monitoring tool. In this study, the interaction between beta-naphthoflavone induction (BNF; 100 mg/kg) and carbon tetrachloride (CCl<sub>4</sub>; 1 mL/kg) hepato-

toxicity was examined in the flounder. Treatment groups composed of control, BNF, CCl<sub>4</sub>, and BNF/CCl<sub>4</sub> were compared in terms of cytochrome P450 isozyme content (LM sub 4b; LM sub 2), catalytic activity, isozyme distributions, SGOT-STPT levels and pathology. CCl<sub>4</sub> administration resulted in significant reductions in both the constitutive P450 (LM sub 2) and the BNF-inducible isozyme (LM sub 4b) as well as elevations in SGOT and SGOT levels. The decline in LM sub 4b isozyme content was reflected by stoichiometric decreases in ethoxresorufin-O-deethylase activities. BNF/CCl<sub>4</sub> coadministration was protective in part against CCl<sub>4</sub> hepatotoxicity. Immunohistochemistry indicated that LM sub 4b was diffusely distributed throughout the liver. These interactions have demonstrated a multiple P450 isozyme involvement, the protective nature of BNF against CCl<sub>4</sub> hepatotoxicity in the flounder, the ability to maintain an inductive response in face of CCl<sub>4</sub> coadministration, and the diffuse distributional pattern of LM sub 4b in the flounder liver. (Author's abstract)  
W91-01279

#### INDUCTION OF PEROXISOME PROLIFERATION IN RAINBOW TROUT EXPOSED TO CIPROFIBRATE

Massachusetts Univ., Amherst. School of Public Health.  
J. H. Yang, P. T. Kosteki, E. J. Calabrese, and L. A. Baldwin.  
Toxicology and Applied Pharmacology TXAPA9, Vol. 104, No. 3, p 476-482, July 1990. 2 fig, 2 tab, 27 ref. US Army Medical Research and Development Command Contract DAMD17-88-C-8051.

Descriptors: \*Biochemical tests, \*Ciprofibrate, \*Fish physiology, \*Path of pollutants, \*Peroxisomes, \*Toxicity, \*Trout, \*Water pollution effects, Bioassay, Enzymes, Immunology, Liver, Sublethal effects, Tissue analysis.

A number of chemicals, especially those used as hypolipidemic drugs and phthalate ester plasticizers, have been identified as peroxisome proliferators. While considerable information on interspecies comparison is available in mammalian models, there is a general lack of information on responses of fish species to peroxisome proliferators. Rainbow trout (*Salmo gairdneri*), average body weight of 450 grams, were treated with 15, 25, or 35 mg/kg of ciprofibrate via intraperitoneal injection every other day for 2 to 3 weeks. The effects on hepatic peroxisomal acyl-CoA oxidase, polypeptide PFA-80, catalase, and liver weight were measured. The treatment of trout with ciprofibrate showed significant dose-related increases in peroxisomal acyl-CoA activity, polypeptide PFA-80 and catalase after 3 weeks of exposure. Peroxisomal oxidase activity showed a significant ( $p = 0.008$ ) increase (78%) at 35 mg/kg and a marginal ( $p = 0.1$ ) increase (27%) at 25 mg/kg after 3 weeks of exposure. Densitometric analysis of polypeptide PFA-80 and catalase showed increases up to 48 and 236% at 35 mg/kg, respectively. Morphometric analysis on livers of trout administered 35 mg/kg for 3 weeks showed a 2.3-fold increase of peroxisomal volume density, as compared to control. This study demonstrates the induction of peroxisome proliferation in rainbow trout administered ciprofibrate, a known peroxisome proliferator in rodents. (Author's abstract)  
W91-01280

#### ECOLOGICAL CORRELATION BETWEEN ARSENIC LEVEL IN WELL WATER AND AGE-ADJUSTED MORTALITY FROM MALIGNANT NEOPLASMS

National Taiwan Univ., Taipei. Inst. of Public Health.  
C. J. Chen, and C. J. Wang.  
Cancer Research CNREA8, Vol. 50, No. 17, p 5470-5474, September 1990. 1 fig, 4 tab, 29 ref. National Science Council, Republic of China NSC-78-0412-B002-79.

Descriptors: \*Arsenic, \*Cancer, \*Mortality, \*Statistical analysis, \*Taiwan, \*Water pollution effects, \*Well water, Bioaccumulation, Blackfoot disease,

## Effects Of Pollution—Group 5C

Epidemiology, Public health, Regression analysis, Statistical studies.

A significant dose-response relation between ingested arsenic and several cancers has recently been reported in four townships of the endemic area of blackfoot disease, a unique peripheral artery disease related to the chronic arsenic exposure in southwestern Taiwan. This study was carried out to examine ecological correlations between arsenic levels of well water and mortality from various malignant neoplasms in 314 precincts and townships of Taiwan. The arsenic content of water in 83,656 wells was determined by a standard mercuric bromide stain method from 1974-1976, while mortality rates of 21 malignant neoplasms among residents in study precincts and townships from 1972-1983 were standardized to the world population in 1976. A significant association with the arsenic level in well water was observed for cancers of the liver, nasal cavity, lung, skin, bladder and kidney in both males and females as well as for prostate cancer in males. These associations remain significant after adjusting for indices of urbanization and industrialization through multiple regression analyses. The multivariate-adjusted regression coefficient indicating an increase in age adjusted mortality per 100,000 person-years for every 0.1 ppm increase in arsenic level of well water was 6.8 and 2.0, 0.7 and 0.4, 5.3 and 5.3, 0.9 and 1.0, 3.9 and 4.2, as well as 1.1 and 1.7 respectively, in males and females for cancers of the liver, nasal cavity, lung, skin, bladder and kidney. The multivariate-adjusted regression coefficient for the prostate cancer was 0.5. These weighted regression coefficients were found to increase or remain unchanged in further analyses in which only 170 southwestern townships were included. (Author's abstract)  
W91-01292

#### RELATIVE SENSITIVITIES OF DIFFERENT LIFE STAGES OF ISOGNOMON CALIFORNICUM TO CADMIUM TOXICITY.

Hawaii Univ., Honolulu. Kewalo Basin Marine Mammal Lab.  
A. H. Ringwood.  
Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 338-340, May/June 1990. 1 fig, 15 ref.

Descriptors: \*Bioassay, \*Cadmium, \*Heavy metals, \*Mollusks, \*Toxicity, \*Toxicology, \*Water pollution effects, Bivalves, Embryonic growth stage, Estuaries, Growth stages, Juvenile growth stage, Larvae, Salinity, Water pollution.

Marine organisms that occur in coastal and estuarine habitats may be exposed to toxic concentrations of trace metals. When acute toxicity (measured on the basis of LC50) is used as a measure of relative sensitivity, it has generally been found that larval stages of fish and invertebrates are killed at lower concentrations of metals than adults. Embryos, four different ages of larvae, juveniles and adults of a Hawaiian bivalve, *IsoGNomon californicum*, were exposed to a range of cadmium concentrations at two salinities to determine 48-hour LC50 and to compare the relative sensitivities of the various life stages. The Cd 48-hour LC50 of embryos, 3-day and 10-day old larvae were similar, at about 0.5 mg/L. Older larvae, 24 and 36-day, also showed a similar sensitivity to each other but their LC50s (4.0 mg/L) were approximately one order of magnitude higher than those of the younger stages. Newly settled juveniles were less sensitive than embryonic or larval stages and adults were the least sensitive. There was a general trend to increased toxicity with decreased salinity, but salinity effects were not significant with late larvae, juveniles, or adults. (Mertz-PTT)  
W91-01308

#### INFLUENCE OF CADMIUM AND ZINC ON CADMIUM TURNOVER IN THE ZEBRAFISH, BRACHYDANIO RERIO.

Uppsala Univ. (Sweden). Dept. of Zoology.  
A. Wicklund, L. Norrgren, and P. Runn.  
Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 348-353, May/June 1990. 2 fig, 2 tab, 16 ref.

Descriptors: \*Bioaccumulation, \*Bioassay, \*Cadmium, \*Fish physiology, \*Heavy metals, \*Path of pollutants, \*Toxicology, \*Water pollution effects, \*Zinc, Chronic toxicity, Radioactive tracers, Synergistic effects, Toxicity, Water pollution, Zebra fish.

A study was made of the dynamics of non-dietary cadmium in fish exposed to different concentrations of cadmium and zinc in water. Zebrafish, *Brachydanio rerio*, were exposed to Cd and Zn for various periods. The fate of a short pulse of the radioactive tracer <sup>109</sup>Cd (3 or 9 days) was studied during a post-pulse period of 53 or 83 days. The majority of the <sup>109</sup>Cd taken up in the gills during the pulse period was retained in the gill tissue and slowly transferred to the internal organs or lost to the water during the post-pulse period. The retention of tracer in the gills after a 3-day <sup>109</sup>Cd pulse was increased by Zn but not by Cd. Continuous exposure to stable Cd increased the rate of turnover of the retained <sup>109</sup>Cd. Both Cd and Zn increased the tracer accumulation in the liver and kidney. The results also indicated that the effect of Zn on the Cd turnover might be lost if the environmental Zn is withdrawn before the start of the <sup>109</sup>Cd pulse. A tendency for increased mortality in the fish exposed to 1 microgram Cd/L for 2-3 months suggested that low concentrations of Cd is toxic to the fish during chronic exposure. The increased Cd uptake and transfer in the gills, caused by Zn, could have deleterious effects on the fish. It might also reflect a change in the form of transport and in the intracellular handling of the metal, which protects the fish from Cd toxicity. However, a Zn pre-exposure did not decrease the mortality, which suggests that Zn did not protect the fish from Cd toxicity. (Mertz-PTT)  
W91-01310

#### EFFECTS OF TRIBUTYL TIN ON DEFENSE-RELATED ACTIVITIES OF OYSTER HEMOCYTES.

Maryland Univ., Cambridge. Horn Point Environmental Lab.  
W. S. Fisher, A. Wishkovsky, and F.-L. E. Chu.  
Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 354-360, May/June 1990. 5 fig, 1 tab, 36 ref. University of Maryland Sea Grant College NA86-AA-D-FG-006.

Descriptors: \*Antifoulants, \*Biocides, \*Oysters, \*Toxicity, \*Toxicology, \*Tributyltin, \*Water pollution effects, Bioassay, Chemiluminescence, Crassostrea, Mollusks, Paints, Salinity, Water pollution.

Tributyltin compounds are used in marine antifouling paints as a biocide. Initial reports on the effects of tributyltin on economically important oysters, *Crassostrea gigas*, demonstrated shell abnormalities. Subsequent research on bivalve molluscs has found tributyltin to affect chromosomes, sex ratio and gamete production, and embryo and larval survival. Several defense-related activities of hemocytes from oysters (*Crassostrea virginica* and *C. gigas*) were assayed in vitro with different levels of tributyltin (0.4-4000 parts per billion) to determine whether defense-related cell mechanisms were affected. Chemiluminescence, a presumptive indicator of phagocytic activity, was reduced with increasing concentrations of tributyltin and preincubation with tributyltin appeared to eliminate chemiluminescence. Locomotion of hemocytes was also retarded by tributyltin, but the ability of the hemocytes to spread to an amoeboid shape was not affected. In vitro salinity regulation of oceanic oyster hemocytes to lower salinities was not affected by tributyltin exposure and salinity regulation of estuarine oyster hemocytes to higher salinities was retarded only after a salinity change from 12 parts per trillion to 36 parts per trillion. (Mertz-PTT)  
W91-01311

#### MACROINVERTEBRATE COMMUNITY RESPONSES TO COPPER IN LABORATORY AND FIELD EXPERIMENTAL STREAMS.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.  
W. H. Clements, D. S. Cherry, and J. Cairns.

Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 361-365, May/June 1990. 3 fig, 2 tab, 22 ref.

Descriptors: \*Copper, \*Heavy metals, \*Macroinvertebrates, \*Streams, \*Toxicity, \*Toxicology, \*Water pollution effects, Caddisflies, Dechlorinated water, Laboratory methods, Mayflies, Water pollution.

Macroinvertebrate community responses to copper in laboratory streams receiving dechlorinated tap water and field streams receiving natural river water were compared. Since both tap water and natural river water were taken from the same source in these experiments, several of the important water quality parameters known to influence heavy metal toxicity were similar. Despite the fact that field streams were initially dominated by metal-sensitive Ephemeroptera, effects of Cu were greater in the laboratory. After 10 days of exposure to Cu (11.3 microgram/L), macroinvertebrate abundance was reduced by 75% in laboratory streams compared to 44% in field streams. In the field, the number of taxa was reduced by 10% in treated streams compared to 56% in the laboratory. The response of dominant taxa to Cu exposure was also greater in the laboratory. In the field, abundance of metal-tolerant caddisflies (Hydropsychidae: Trichoptera) was similar in control and treated streams (11.3 microgram/L). These organisms were reduced by 71% in laboratory streams at similar Cu levels. The greater impact of Cu observed in laboratory streams may have resulted from the inability of certain taxa to acclimate to laboratory conditions. The usefulness of community-level toxicity tests in the laboratory may be limited due to the overestimation of metal toxicity. Further research should be conducted in field mesocosms receiving water directly from the system under investigation. (Author's abstract)  
W91-01312

#### ACUTE TOXICITY OF BORON, MOLYBDENUM, AND SELENIUM TO FRY OF CHINOOK SALMON AND COHO SALMON.

National Fisheries Contaminant Research Center, Yankton, SD. Field Research Station.  
S. J. Hamilton, and K. J. Buhl.  
Archives of Environmental Contamination and Toxicology AEETCV, Vol. 19, No. 3, p 366-373, May/June 1990. 7 tab, 39 ref.

Descriptors: \*Acute toxicity, \*Boron, \*Fish physiology, \*Molybdenum, \*Salmon, \*Selenium, \*Toxicology, \*Water pollution effects, Brackish water, Freshwater, Growth stages, Oncorhynchus, Selenates, Selenites, Toxicity, Water pollution.

The acute toxicities of boron, molybdenum, and various forms of selenium, individually and in environmentally relevant mixtures, to swim-up and advanced fry of chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) were determined in site-specific fresh and brackish waters. Boron and molybdenum were relatively nontoxic (96-hour LC50 > 100 mg/L) to both life stages of both species. Selenite was significantly more toxic than selenate to both species. Swim-up fry tested in fresh water were significantly more sensitive than advanced fry in brackish water to selenate and selenite. No mortalities occurred in any concentrations tested of seleno-DL-methionine; however, in the highest concentration (21.6 mg Se/L), at least 50% of the fish showed pronounced surfacing behavior. Coho salmon were more sensitive than chinook salmon to both selenate and selenite at either life stage; only the swim-up fry of coho salmon were more sensitive than chinook salmon to boron. In additional tests with swim-up chinook salmon, differences in the characteristics of the dilution water did not significantly modify the relative toxicities of boron, selenate, and selenite. In binary mixture studies, the joint acute toxic action of selenate and selenite, combined in various ratios, was additive to both species. Based on a comparison of the individual acute values for chinook salmon to the expected environmental concentrations, the margin of safety for boron was only 56 in fresh and 46 in brackish water. The margins of safety for selenate and sele-

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

nite exceeded 275 in both fresh and brackish waters. However, the margin of safety for both selenate and selenite in the mixture test was 145 in fresh water and 220 in brackish water. (Author's abstract)  
W91-01313

#### SELENIUM ACCUMULATION AND ELIMINATION IN MALLARDS.

Patuxent Wildlife Research Center, Laurel, MD. For primary bibliographic entry see Field 5B. W91-01314

#### BEHAVIORAL INDICATORS OF SUBLETHAL TOXICITY IN RAINBOW TROUT.

National Fisheries Contaminant Research Center, Columbia, MO.  
E. E. Little, R. D. Archeski, B. A. Flerov, and V. I. Kozlovskaya.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 3, p 380-385, May/June 1990. 2 tab, 29 ref.

Descriptors: \*Agricultural chemicals, \*Chronic toxicity, \*Fish behavior, \*Toxicity, \*Toxicology, \*Trout, \*Water pollution effects, Carbaryl, Chlordane, Dimethylamine salts, Methyl parathion, Oncorhynchus, Pentachlorophenol, Sublethal effects, Tributyl phosphorothioate, Water pollution.

Four measures of behavior—spontaneous swimming activity, swimming capacity, feeding behavior, and vulnerability to predation—were assessed as indicators of sublethal toxicity in rainbow trout (*Oncorhynchus mykiss*) in 96-hour exposures to sublethal concentrations of six agricultural chemicals: carbaryl, chlordane, dimethylamine salt of 2,4-dichlorophenoxyacetic acid, tributyl phosphorothioate, methyl parathion, and pentachlorophenol. After exposures, behavioral changes consistently demonstrated sublethal toxicity, but effects on specific behaviors varied with contaminants and the concentrations were altered by the water quality criterion concentration for chlordane (2 microgram/L), and at a concentration of tributyl phosphorothioate (5 microgram/L) that had previously been shown to inhibit growth and survival after a 90-day exposure. Feeding behavior was inhibited most by exposure to tributyl phosphorothioate, 2,4-dichlorophenoxyacetic acid, and methyl parathion. Vulnerability to predation was heightened most by exposure to carbaryl and pentachlorophenol. Although all chemicals inhibited spontaneous swimming activity, only carbaryl, tributyl phosphorothioate, and 2,4-dichlorophenoxyacetic acid influenced swimming capacity. (Author's abstract)  
W91-01315

#### SPECIES-SPECIFIC REACTION OF LIVER ULTRASTRUCTURE IN ZEBRAFISH (*BRACHYDANIO RERIO*) AND TROUT (*SALMO GAIARDNERI*) AFTER PROLONGED EXPOSURE TO 4-CHLOROANILINE.

Heidelberg Univ. (Germany, F.R.). Dept. of Zoology 1.  
T. Braunbeck, B. Storch, and H. Bresch.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 3, p 405-418, May/June 1990. 32 fig, 68 ref. Federal Republic of Germany UFOPLAN (environmental research program) FE-Nr. 10603046 and German Research Foundation DFG St 75/9.

Descriptors: \*Chloroaniline, \*Fish, \*Fish physiology, \*Pesticide toxicity, \*Pesticides, \*Toxicity, \*Toxicology, \*Trout, \*Water pollution effects, \*Zebra fish, Chronic toxicity, Tissues, Water pollution.

The morphological alterations of hepatocytes of female zebrafish, *Brachydanio rerio*, and fingerling rainbow trout, *Salmo gairdneri*, following prolonged exposure to 0.04, 0.2, and 1 mg/L of 4-chloroaniline were investigated by means of light and electron microscopy. Changes in peroxisomes were visualized by cytochemical demonstration of catalase activity after incubation in the alkaline diaminobenzidine medium. The amount of storage products was illustrated by the silver impregnation

technique. In a dose-dependent manner, the reaction of female zebrafish liver is characterized by a disturbance of hepatocytic compartmentation, progressive fenestration and fractionation of the rough endoplasmic reticulum, a decrease in the number of peroxisomes and catalase activity, stratified inclusions in mitochondria, and an augmentation of lysosomes and myelinated bodies. Trout hepatocytes display nuclear inclusions, fractionation and vesiculation of the endoplasmic reticulum, and an increase in mitochondria, but a decrease of peroxisomes and catalase activity. Whereas glycogen stores are exhausted at 1 mg/L 4-chloroaniline, lipid deposits are amplified. An elevated rate of hepatocytic mitosis as well as the occurrence of glycogen-condensing cells probably derived from hepatocytes indicate the induction of proliferative processes in trout liver. Evaluation and comparison of results with earlier reports suggest that despite the unspecificity of some alterations, the combination of pathological symptoms yields a syndrome specific for the species and the substance studied. As a consequence, histological and cytological investigations are recommended as a routine supplement in an integrated test schedule for the assessment of sublethal effects of pollutants in the aquatic environment. (Author's abstract)  
W91-01317

#### LONG-TERM TOXICITY TEST COMPRISING REPRODUCTION AND GROWTH OF ZEBRAFISH WITH 4-CHLOROANILINE.

Bundesforschungsanstalt fuer Ernährung, Karlsruhe (Germany, F.R.).  
H. Brach, H. Beck, D. Ehlermann, H. Schlaszus, and M. Urbanek.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 3, p 419-427, May/June 1990. 4 fig, 1 tab, 28 ref. Federal Environmental Agency (FRG) UFOPLAN (environmental research program) FE-Nr. 10603046.

Descriptors: \*Bioassay, \*Bioindicators, \*Fish physiology, \*Pesticide toxicity, \*Testing procedures, \*Toxicity, \*Toxicology, \*Water pollution effects, Chronic toxicity, Fish eggs, Long-term test, Reproduction, Zebra fish.

A long-term test over three generations was conducted, using zebrafish (*Brachydanio rerio*) as the test species and concentrations of 1, 0.2, and 0.04 mg/L 4-chloroaniline as a model substance. The effect of the compound on the ecologically important parameters of reproduction and growth was studied. Reduction in egg release by fish raised under 4-chloroaniline was the most sensitive parameter in the test. Compared to the toxic threshold concentration for growth (0.4 mg/L), egg release was affected by a ten-fold lower concentration (0.04 mg/L). Results show that long-term study is the most appropriate method to assess the chronic toxicity of a substance on fish. Long-term tests start with eggs from unexposed parents and continue into a second generation, because sexual maturity of fish from the first generation will not show disturbances in growth or reproduction caused by abnormal development of gonads. To reveal such effects the test should either begin with adult fish exposed to the test substance and continue through the growth of at least one generation, or a test should be started with eggs from unexposed parents and then should be conducted until sexual maturity of the second generation. (Mertz-PTT)  
W91-01318

#### ACID PRECIPITATION AND FOOD QUALITY: INHIBITION OF GROWTH AND SURVIVAL IN BLACK DUCKS AND MALLARDS BY DIETARY ALUMINUM, CALCIUM, AND PHOSPHORUS.

Patuxent Wildlife Research Center, Laurel, MD. D. W. Sparling.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 3, p 457-463, May/June 1990. 5 fig, 4 tab, 27 ref.

Descriptors: \*Acid rain effects, \*Aluminum, \*Calcium, \*Ducks, \*Phosphorus, \*Water pollution effects, \*Waterfowl, Black ducks, Diets, Growth, Mallards, Mortality.

In areas impacted by acid precipitation, water chemistry of acidic ponds and streams often changes, resulting in increased mobilization of aluminum and decreased concentration of calcium carbonate. Aluminum binds with phosphorus and inhibits its uptake by organisms. Thus, invertebrate food organisms used by waterfowl may have inadequate Ca and P or elevated Al for normal growth and development. Acid rain and its effects may be one of the factors negatively impacting American black ducks (*Anas rubripes*) in eastern North America. One-day old mallards (*A. platyrhynchos*) and black ducks were placed on one of three Ca:P regimens: low:low, normal:normal, and low:high with each regimen divided further into three or four Al levels for 10 weeks. 45% of the black ducks died on nine different diets whereas only 28% of the mallards died on three different diets. Mortality was significantly related to diet in both species. Growth rates for body weight, culmens, wings, and tarsi of both species on control diets exceeded those on many treatment diets but the differences were less apparent for mallards than for black ducks. Differences among treatments were due to both Ca:P and Al levels. Over a period of two to three weeks, high Al diets coupled with low Ca and P were most toxic to ducklings. Al was toxic even when Ca and P levels approximated generally accepted dietary levels. Elevated levels of P may reduce mortality of birds on high Al compared with those on diets with low Ca and P, but comparable Al levels. (Mertz-PTT)  
W91-01320

#### EFFECT OF PH ON THE ACCUMULATION KINETICS OF PENTACHLOROPHENOL IN GOLDFISH.

Washington State Univ., Pullman. Coll. of Pharmacy.  
For primary bibliographic entry see Field 5B. W91-01321

#### METABOLIC EFFECTS OF KRAFT MILL EFFLUENTS ON THE EEL *ANGUILLA ANGUILLA* L.

Aveiro Univ. (Portugal). Dept. of Biology.  
M. A. Santos, F. Pires, and A. Hall.  
Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 1, p 10-19, August 1990. 10 fig, 4 tab, 21 ref. Portuguese INIC Contract 85/CNA/6.

Descriptors: \*Eel, \*Fish physiology, \*Kraft mill wastes, \*Pulp and paper industry, \*Pulp wastes, \*Water pollution effects, Anguilla, Portugal, Tissues, Wastewater, Water pollution.

In Portugal, large quantities of Kraft pulp mill wastes are discharged into estuarine and fresh waters and young fish and their prey may be affected by prolonged exposure to dilute concentrations of kraft and pulp mill effluents. Yellow eels (*Anguilla anguilla* L.) with an average weight of 60 g were caught in June/July at the Aveiro Lagoon on the Portuguese West Coast, transported to the Department of Biology, Aveiro University, and kept in aerated aquaria for 1 week before the experiment started. The eels were then exposed for 1 and 3 weeks to 75 and 50% of the kraft pulp mill effluent. The eels exposed to the kraft pulp mill effluent developed an increase in red blood cell number per cubic millimeter and several biochemical changes, such as an increase in plasma lactate and sodium and a decrease in plasma pyruvate and potassium. Histological examination of the experimental eels exposed to the 50% kraft pulp mill effluent revealed deep alteration of the tissue structure, such as disruption of the skin and edematous hypertrophy of covering epithelial cells in secondary gill lamellae. The kidney had damage of the renal tubules. The liver developed necrosis supported by a significant decrease in glutamic oxaloacetic transaminase and glutamic pyruvic transaminase activity. The spleen had an increase in blood content as well as in pigment centers. Previous results indicated that kraft pulp mill effluent causes tissue damage and consequent metabolic changes in the eel *Anguilla anguilla* L. (Mertz-PTT)  
W91-01323

## Effects Of Pollution—Group 5C

**IN VIVO RECOVERY OF GLYCOGEN METABOLISM IN HEMOLYMPH AND TISSUES OF A FRESHWATER FIELD CRAB BARYTELPUSA GUERINI ON EXPOSURE TO HEXA-VALENT CHROMIUM.**

Osmania Univ., Hyderabad (India). Dept. of Zoology.

N. B. R. K. V. Gopal, A. M. Chandravathy, S. Sultana, and S. L. N. Reddy.

Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 1, p 20-29, August 1990. 5 tab, 30 ref.

Descriptors: \*Bioassay, \*Chromium, \*Crabs, \*Crustaceans, \*Toxicity, \*Water pollution effects, Barytelphusa, Chromates, Chronic toxicity, Dichromate, Physiology, Tissues, Water pollution.

Hexavalent chromium most often appears as a water-soluble chromate or dichromate, both powerful oxidants that can easily penetrate biologic membranes and irritate cells. These compounds are extensively manufactured and utilized by many industries; often they are found in industrial effluents. The in vivo toxic effects of hexavalent chromium (20 mg/L) on hemolymph glucose, tissue glycogen, total free sugars, and active and total phosphatases of an edible, freshwater crab *Barytelphusa guerini* were studied. In a 15-day exposure span followed by a 15-day postexposure recovery, the time-course alterations in these constituent segments of the glycogen metabolism indicate an inconsistent depletion in metabolite levels and elevated enzyme activities during exposure period as well as hyperglycemia. The persisting trend of the alterations in glycogen metabolism observed in the tissues of crabs even after their transfer to toxicant-free water suggests the retention and slow elimination of this metal species. However, the pattern of biochemical alterations are not time-dependent, and deviation in responses to Cr(VI) exposure suggests that the differential uptake into tissues and a subsequent redistribution of this anionic metal may possibly account for the varied disturbances in the tissues and reflect the susceptibility of crabs to chromium toxicity. (Mertz-PTT) W91-01324

**EFFECT OF COPPER SULFATE ON HEMATOLOGY, BLOOD CHEMISTRY, AND HEPATO-SOMATIC INDEX OF AN INDIAN CATFISH, HETEROPNEUSTES FOSILLIS (BLOCH), AND ITS RECOVERY.**

Meerut Univ. (India). Dept. of Zoology.

H. S. Singh, and T. V. Reddy.

Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 1, p 30-35, August 1990. 1 tab, 25 ref.

Descriptors: \*Algicides, \*Bioassay, \*Catfish, \*Copper sulfate, \*Fungicides, \*Toxicity, \*Water pollution effects, Fish, Fish physiology, Heteropneustes, Parasiticide, Tissues, Water pollution.

Copper sulfate is one of the oldest chemicals used as an algicide, a fungicide, and a parasiticide in fish culture, and is commonly considered to be 100% active. Apart from its help to pisciculturists, it has the serious disadvantage of being toxic to fish. The effect of CuSO<sub>4</sub> (0.25 parts per million) on hematology, blood chemistry, and hepato-somatic indices was studied in the Indian catfish, *Heteropneustes fossilis* (Bloch). Analysis of various parameters was made after 24 hours, and 5, 10, 20, and 30 days of CuSO<sub>4</sub> exposure. Subsequently, some fish were allowed recovery periods of 24 hours and 5 days in normal water. Fish were normal in the early periods of CuSO<sub>4</sub> intoxication, but later they became lethargic and began surfacing frequently to gulp air. There were numerous immature erythrocytes and broken fragments of blood corpuscles visible in the Neubauer chamber when the cells were counted. Physiological functions, such as hemopoiesis, metabolism in general, excretory and respiratory failure, and ionic imbalance were affected. The results indicate that hematological and biochemical parameters and hepato-somatic index values are good indicators of CuSO<sub>4</sub> intoxication of *H. fossilis* (Bloch). (Mertz-PTT) W91-01325

**EFFECT OF 3,4-DICHLOROANILINE AND METAVANADATE ON DAPHNIA POPULATIONS.**

Centre for Technology and Policy Studies TNO, Apeldoorn (Netherlands). Dept. of Biology.

N. van der Hoeven.

Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 1, p 53-70, August 1990. 10 fig, 1 tab, 16 ref, append.

Descriptors: \*Bioassay, \*Daphnia, \*Dyes, \*Model studies, \*Toxicity, \*Water pollution effects, Aquatic populations, Dichloroaniline, Growth, Kooijman model, Metavanadate, Pollutants, Population dynamics, Population exposure, Toxicants, Water pollution.

To compare the effects of toxicants on individuals with those on populations, a population model was developed for daphnids based on some facts about the development of individual daphnids and on some more general assumptions. The Kooijman model provides reasonable predictions on the individual level. The parameters in the model have a physical interpretation, making it possible to translate the effect of a toxicant to a change in parameter value. It can only be extended to population levels by extensive computer simulations. Fourteen continuously fed populations of *Daphnia magna* were exposed to 3,4-dichloroaniline or metavanadate and monitored for 20 (two controls), 14 (six with metavanadate), and 8 (six with 3,4-dichloroaniline) weeks. The controls showed a damped oscillation. Low concentrations of either 3,4-dichloroaniline or metavanadate stimulated the first population peak. High concentrations of metavanadate rendered population peaks less regular, and at the highest metavanadate concentration, one population perished. High concentrations of 3,4-dichloroaniline slightly reduced population size. Four periodically fed populations of *D. magna* were also monitored. The more they were fed, the larger they grew. In the continuously fed populations, ephippia were formed at and just after the population peaks. No ephippia were noted in the periodically fed populations. Metavanadate promoted the formation of ephippia, and 3,4-dichloroaniline depressed sexual reproduction at all concentrations tested. The population dynamics of the controls were compared with those predicted by Kooijman's model for growth and reproduction of individual daphnids. In general, there is reasonable agreement between model predictions and observations, but some adjustments to the model may be necessary. (Mertz-PTT) W91-01326

**INCORPORATION OF A SUBACUTE TEST WITH ZEBRA FISH INTO A HIERARCHICAL SYSTEM FOR EVALUATING THE EFFECT OF TOXICANTS IN THE AQUATIC ENVIRONMENT.**

Swedish Environmental Research Inst., Stockholm.

A. H. Neilson, A. S. Allard, S. Fischer, M. Malmberg, and T. Viktor.

Ecotoxicology and Environmental Safety EESADV, Vol. 20, No. 1, p 82-97, August 1990. 12 tab, 69 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Chlorinated hydrocarbons, \*Fish physiology, \*Pesticide toxicity, \*Phenolic pesticides, \*Toxicity, \*Water pollution effects, Hydrogen ion concentration, Testing procedures, Water pollution, Zebra fish.

Single-species laboratory tests were used to assess the acute toxicity of halogenated phenolic compounds. Subacute, preexposure and postexposure tests were examined. 4,5,6-trichloroguaiacol and 3,4,5-trichlorophenol were tested in each system. Other compounds tested included a range of chlorophenols, bromophenols, nitrophenols, 2,4,5-trichloroanisole, 2,4,6-tribromoanisole, and 1,2,3-trichlorobenzene. No single test system was most sensitive to all of the compounds examined, substantial variations in the sensitivity of the various organisms were noted, and there was no correlation between the toxicities assayed with different test systems. The zebra fish (*Brachydanio rerio*) embryo/larvae system was used to examine subacute effects using two of the compounds, and a protocol was devel-

oped with 6 weeks preexposure to the toxicant. Preexposure decreased the lowest observable effect concentration by a factor of about 4, and the effect was completely reversible during a 6-week postexposure period in the absence of the toxicant. An enclosed system for carrying out the zebra fish embryo/larvae test was developed and evaluated with three neutral volatile compounds: the median survival time and the frequency of occurrence of deformation were examined as end points. The effect of pH on toxicity was evaluated in buffered media for four of the test systems: toxicity increased markedly at the lower pH values, and it could be shown that the ionized forms of the phenols were not the only contributors to toxicity. It is proposed that the zebra fish system incorporating preexposure could be incorporated into a hierarchical system using a range of organisms for assessing acute toxicity in single species under laboratory conditions and multicomponent systems simulating natural ecosystems. (Mertz-PTT) W91-01327

**ENVIRONMENTAL IMPACT OF NORTH SEA OIL.**

Dundee Univ. (Scotland). Dept. of Biological Sciences.

A. M. Jones.

Science Progress SCPRAY, Vol. 73, No. 292.4, p 457-468, 1989. 2 fig, 1 tab, 36 ref.

Descriptors: \*Environmental effects, \*Environmental impact, \*North Sea, \*Oil industry, Environmental policy, Impact assessment, Oil pollution, Resources development.

The North Sea is a geographically large area of continental shelf water bordered by several countries. It has a surface area of some 575,000 square km and a volume of about 54,000 cubic km. The exploitation of gas began in 1965, while that of oil began in 1969. The development of North Sea oil has been a complex technological exercise and the potentials for impact have been many and varied. The impacts range from the development of the offshore exploration and extraction facilities, often taking place in a hostile environment and at the limits of the current technology, to the socioeconomic consequences of the, often temporary, high-wage economy associated with the construction phase of development. The major threats posed by the development of North Sea oil have so far been avoided through the joint activities of industry, planners and scientists. Most incidents have been local in effect and even in major accidents little real damage has resulted. The unpredictability of many inputs led to a need for monitoring programs to ensure that undesirable trends do not develop in sensitive areas or as a result of new technology being applied. The techniques of monitoring have been the source of much debate and have suffered from a lack of geographical integration: the need for more fundamental understanding of ecological change remains a problem for ecologically based programs. The difficulties of interpretation at the community and/or population level have led to the investigation of more physiological and cellular-level approaches to monitoring which offer considerable promise but which have not yet overcome the general problem of relating the observations to specific contaminants in a multiple-stress situation which is so common. There is good evidence that this approach is valuable, however, in indicating stressed populations and this is an important first step in monitoring objectives. (Mertz-PTT) W91-01329

**DECOMPOSITION RATE, CHEMICAL COMPOSITION AND NUTRIENT RECYCLING OF NYMPHAEA ALBA L. FLOATING LEAF BLADE DETRITUS AS INFLUENCED BY PH, ALKALINITY AND ALUMINUM IN LABORATORY EXPERIMENTS.**

Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.

For primary bibliographic entry see Field 2H. W91-01332

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

#### SPIROGYRA SPECIES AND ACCOMPANYING ALGAE FROM POOLS AND DITCHES IN THE NETHERLANDS.

Vrije Univ., Amsterdam (Netherlands). Biological Lab.  
J. Simons, and A. P. van Beem.  
Aquatic Botany AQBODS, Vol. 37, No. 3, p 247-269, August 1990. 4 fig, 10 tab, 33 ref.

Descriptors: \*Algae, \*Chlorophyta, \*Ditches, \*Ponds, \*Spirogyra, \*The Netherlands, \*Water pollution effects, Acidity, Alkalinity, Nutrients, Species diversity.

In ditches and moorland pools zygomatic algae, especially Spirogyra make up an important and often dominant component of floating algae. Of the total number of 60 Spirogyra species recorded in the Netherlands, 47 species were recorded in ditches and pools. Sirogonium was represented by only one species, S. sticticum (Engl. Bot) Wille, and Mougeotia and Zygnema by seven and six species, respectively. In hardwater ditches, especially at sites with relatively low pollution, Spirogyra forms a richly diversified component with up to approximately 20 species per site. At hardwater sites with appreciable pollution Spirogyra is suppressed or replaced by massive growths of algae such as Cladophora, Vaucheria, Enteromorpha or Hydrodictyon. At low alkaline and slightly acid sites, the number of species per site is considerably lower. Under conditions with pH values <5, Spirogyra does not occur and is replaced by Mougeotia, Zygnema, Klebsormidium, Microspora, and some others. Periodicity was observed in Spirogyra with a peak in spore production occurring in the second half of May and the first half of June. Spores were more frequently observed in hardwater habitats than in low-alkaline environments. Most species have wide ranges of occurrence; 22 species were found in low alkaline and slightly acid habitats, but most of these species are not restricted to such environments. Presumably they are adapted to nutrient-poor conditions. In eutrophic hardwater ditches, Spirogyra granulata Jao and S. singularis Nordst. appeared to be very tolerant to pollution. Species such as Spirogyra nitida (Dillw.) Link and S. majuscula Kutz. seem to indicate seepage of groundwater in otherwise nutrient-rich environments. (Author's abstract) W91-01333

#### PHOSPHATE (32P)-UPTAKE CAPABILITIES OF NATURAL PICOPLANKTON AND ULTRAPLANKTON COMMUNITIES IN LAKES OF DIFFERING DEGREES OF EUTROPHICATION.

Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Abt. Oekophysiology.  
H. Rai, and T. R. Jacobsen.  
Archiv fuer Hydrobiologie AHYBA4, Vol. 118, No. 4, p 421-435, June 1990. 4 fig, 3 tab, 40 ref.

Descriptors: \*Aquatic bacteria, \*Eutrophic lakes, \*Eutrophication, \*Germany, \*Limnology, \*Phosphates, \*Phytoplankton, Carbon, Differential fractionation, Orthophosphates, Particle size, Picoplankton, Radioisotopes, Tracer studies, Ultraplankton.

Differential fractionation of P32 as PO4 uptake in North Germany Baltic lakes of varying trophic states was done to distinguish the activity of phytoplankton and bacterioplankton. In all the lakes studied, orthophosphate uptake was overwhelmingly associated with the smallest size particles (<1 microm). Therefore, it is inferred that the bacterioplankton (<1 microm) are responsible for the uptake of orthophosphate in situ conditions, regardless of the ambient phosphorus concentrations of the lakes. P32-uptake kinetics of size-fraction planktonic cells were conducted in mesotrophic Schorsee to determine size preference of phosphate uptake. Uptake rates in the 0.2-10 microm fraction were more than 60% (61-98%) of the 10-250 microm size particles. These findings are consistent with earlier studies that inferred that small cells should have extraordinary uptake capabilities for phosphate. Picoplankton and ultraplankton along with the heterotrophic bacteria are the major trophic groups responsible for phosphate and carbon metabolism in the lakes studied. (Author's abstract)

W91-01336

#### LONG TERM PATTERNS IN NUTRIENTS, PHYTOPLANKTON AND ZOOPLANKTON OF LAKE KINNERET AND FUTURE PREDICTIONS FOR ECOSYSTEM STRUCTURE.

Kinneret Limnological Lab., Tiberias (Israel).  
M. Gophen, S. Serruya, and S. Threlkeld.  
Archiv fuer Hydrobiologie AHYBA4, Vol. 118, No. 4, p 449-460, June 1990. 6 fig, 1 tab, 21 ref.

Descriptors: \*Eutrophication, \*Lake Tiberias, \*Limnology, \*Nutrients, \*Phytoplankton, \*Water pollution effects, \*Zooplankton, Algae, Fisheries, Israel, Jordan River, Lakes, Monitoring, Nitrogen, Phosphorus.

Long-term records on nutrients, phytoplankton and zooplankton for Lake Kinneret, Israel were examined and indicated that there was reason for concern over future water quality. The discharge of the river and the concentration of major nutrient species in the river were monitored at least once monthly since October 1967 at a station 11 km above the lake and at stations on three Jordan headwater rivers (20-30km above Lake Kinneret). It was concluded that nutrient loading from the Jordan River has changed qualitatively in recent years, with ammonia and soluble phosphorus increasing relative to other forms of nitrogen and phosphorus. Total N in Lake Kinneret has been decreasing and total P has been increasing, resulting in an overall decline in the N:P ratio. Zooplankton biomass has been decreasing, as stocking of commercially favored fish species has increased and fishing pressure on dominant zooplanktivorous fish has decreased. Changes in nutrient loading and in fishery management appear to favor future development of less desirable species of algae in Lake Kinneret. (White-Reimer-PTT) W91-01337

#### EPIPHYTIC ZOOBENTHOS DENSITY AND BIOMASS WITHIN LOW ALKALINITY, OLIGOTROPHIC LAKES ON THE CANADIAN SHIELD.

Toronto Univ. (Ontario). Inst. for Environmental Studies.  
R. France.  
Archiv fuer Hydrobiologie AHYBA4, Vol. 118, No. 4, p 477-499, June 1990. 3 fig, 4 tab, 86 ref.

Descriptors: \*Acid rain effects, \*Alkalinity, \*Benthic fauna, \*Canada, \*Oligotrophic lakes, \*Precambrian Shield, Biomass, Chlorophyll a, Correlation analysis, Depth, Hydrogen ion concentration, Lake morphometry, Light penetration, Littoral communities, Macroinvertebrates, Nitrogen, Ontario, Phosphorus, Population density, Standing crops.

The phytofaunal macroinvertebrate communities within the shallow littoral zones of 19 Ontario Shield lakes were examined during the ice-free seasons of 1984 and 1985. Neither total zoobenthos density nor biomass were linearly correlated with lake pH, alkalinity, total phosphorus (TP), total nitrogen, or chlorophyll-a concentrations. However, the standing crops of several taxa were significantly related to these and other limnological variables without discernable trends with regard to the summed totals. For example, lakes of high alkalinity (>3.5 mg CaCO3/L) had a large percentage of their total biomass composed of gastropods and turbellarians in contrast to lakes of low alkalinity (<1.0 mg/L) which were dominated by odonates and water mites. Secchi depth was the best trophic predictor of total density (r = -0.67) and total biomass (r = -0.63). The possibility of some dependence of littoral zoobenthos on allochthonous energy sources, and the potential for buffering within macrophyte beds, are both unknown, which, together with the narrow range of chemical variables in these lakes (e.g pH from 5.5 to 6.7 and TP from 5 to 14 mg/cu m), may explain the absence of strong chemical correlates of zoobenthos standing crop. There was a hyperbolic relationship between phytofaunal biomass and lake mean depth. The best single predictor of total biomass for the subset of 8 intensively sampled lakes was maximum depth (r = -0.92). The most

productive direction towards predicting littoral zoobenthos standing crop may be the development of models relating macroinvertebrates to macrophytes and basin morphometry. (Author's abstract) W91-01338

#### OCCURRENCE OF LIMNIC MICRO-CRUSTACEANS IN RELATION TO PH AND HUMIC CONTENT IN SWEDISH WATER BODIES.

Uppsala Univ. (Sweden). Limnologiska Institutionen.  
For primary bibliographic entry see Field 2H.  
W91-01350

#### CULTURAL EUTROPHICATION OF WEST POINT LAKE—A 10-YEAR STUDY.

Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.  
D. R. Bayne, W. C. Seesock, C. E. Webber, and J. A. McGuire.  
Hydrobiologia HYDRB8, Vol. 199, No. 2, p 143-156, July 24, 1990. 6 fig, 4 tab, 34 ref.

Descriptors: \*Eutrophic lakes, \*Eutrophication, \*Georgia, \*Phytoplankton, \*Primary productivity, \*Water pollution effects, \*West Point Lake, Algae, Chlorophyll a, Conductivity, Nutrient enrichment, Reservoirs, Seasonal variation, Wastewater pollution.

Mean annual phytoplankton primary productivity of West Point Lake in Atlanta, Georgia, increased significantly during a 10-year period from 1976 (350 mg C/sq m/d) to 1985 (1580 mg C/sq m/d). The increased productivity was apparently caused by nutrient enrichment of the lake waters resulting from the significant increase in volume of treated sewage effluent and urban runoff associated with expanded urbanization of the Atlanta, Georgia, metropolitan area. With the exception of 1985, when conductivity and total phosphorus concentrations were significantly higher, monthly measurements of nutrient concentrations in the headwaters of the reservoir failed to reflect the eutrophication that was occurring. Multiple regression analysis revealed that, during the cool season, chlorophyll a was the most important variable in terms of explaining variations in primary productivity. During the warm season, specific conductance was most important. Volume of treated wastewater entering the reservoir was significantly related to primary productivity during both the cool and warm seasons. Except for 1985 when the mean annual chlorophyll a concentration (19.7 microg/L) was significantly higher than all other years, the chlorophyll content of the lake remained fairly stable (6.9-13.6 microg/L). Increased productivity in the absence of higher algal biomass was caused by more efficient photosynthesis by the algal community. The improved photosynthetic efficiency apparently occurred because of a shift in algal dominance from relatively large diatoms to relatively small green and blue-green taxa. (Author's abstract) W91-01354

#### SHORT TERM BIOTIC RESPONSE BEFORE AND DURING THE TREATMENT OF AN ACID MINE DRAINAGE WITH SODIUM CARBONATE.

Q.C. Services, Teton, ID.  
For primary bibliographic entry see Field 5G.  
W91-01358

#### DISTRIBUTION OF SHORT CHAIN CARBOXYLIC ACIDS IN EUTROPHIC DRAINAGE CHANNELS.

Sussex Univ., Brighton (England). School of Biological Sciences.  
For primary bibliographic entry see Field 5B.  
W91-01359

#### PHARMACOKINETIC MODELING IN AQUATIC ANIMALS. I. MODELS AND CONCEPTS.

Dow Chemical Co., Midland, MI. Environmental Toxicology and Chemistry Research Lab.

## Effects Of Pollution—Group 5C

For primary bibliographic entry see Field 5A.  
W91-01361

# **SURVIVAL OF EARLY LIFE STAGES OF BROWN TROUT (*SALMO TRUTTA* L.) IN RELATION TO ALUMINIUM SPECIATION IN UPLAND WELSH STREAMS.**

University Coll., Cardiff (Wales). School of Pure and Applied Biology.  
N. S. Weatherley, A. P. Rogers, X. Goenaga, and S. J. Ormerod.

Aquatic Toxicology AQOTODG, Vol. 17, No. 3, p 213-229, September 1990. 3 fig, 3 tab, 48 ref, append.

Descriptors: \*Acid rain effects, \*Fish populations, \*Trout, \*Water pollution effects, Aluminum, Fish eggs, Hydrogen ion concentration, Lethal limit, Survival.

The survival of artificially implanted eggs, alevins and parr of brown trout (*Salmo trutta* (L.)) was assessed in streams of different acidity. Chemical analysis included detailed aluminum speciation of surface and interstitial water samples, taken over the duration of intragravel life stages. Egg survival, from two minutes after fertilization to hatching, was usually above 71%, and was independent of the mean concentration of total monomeric aluminum over the range 3-397 micrograms/L. The survival of alevins exposed for 28 days (before 'swim up') or 42 days ('swim up') was most strongly related to mean monomeric aluminum concentration and to pH. For 28 and 42 day exposures, LC50 values for monomeric aluminum were approximately 19 and 15 micrograms/L, respectively, or 79 and 72 micrograms/L for 0.45 micrometer filterable aluminum. The 21 day LC50 of parr ca. 3 month old, was between 84 and 105 micrograms/L mean filterable aluminum concentration. During a simulated acid episode of mean pH 4.8 and 880 micrograms filterable aluminum/L parr showed 100% mortality after 18 hours. As exemplified in this study, chemical variables show wide and rapid fluctuations, and are often co-correlated. These features confuse interpretation of field experiments or prediction from laboratory data. (Author's abstract)

W91-01362

# **MOLLUSCIDAL AND PISCICIDAL PROPERTIES OF COPPER(II) TETRAOXOSULFATE(VI) ON *BULINUS GLOBOSUS* (MORELET) AND *CLARIAS ANGUILOLARI* (L.).**

Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Biological Sciences.

S. Ebele, A. A. Oladimeji, and J. A. Daramola.  
Aquatic Toxicology AQOTODG, Vol. 17, No. 3, p 231-238, September 1990. 5 fig, 16 ref.

Descriptors: \*Copper compounds, \*Fish, \*Snails, \*Toxicology, \*Water pollution effects, Bioaccumulation, Bioassay, Copper tetraoxosulfate, Ecotoxicology, Fish physiology, Gills, Lethal limit, Toxicity.

The lethal effects of a chemical molluscicide, copper(II) tetraoxosulfate (VI), on *Clarias anguillaris* and *Bulinus globosus* were investigated. The fish were exposed to various concentrations of the chemical in 48, 72 and 96-h static bioassays, while the exposure time for the snails was 24 hours. The LC50 for the various treatments were calculated after corrections were made for natural responsiveness. The molluscicidal concentration was found to be lower than the piscicidal concentration. The histopathology of the gills of the fish revealed a general damage of the gill filaments probably leading to impairment of ion and oxygen uptake. Even though the molluscicidal concentration of copper(II) tetraoxosulfate is sublethal to *C. anguillaris*, consideration should be given to a long term accumulation of copper in the fish which in the end might reach the lethal concentration for the fish. Furthermore there exists the danger of subsequent passage of copper along the trophic chain which, in this case involves man. (Lantz-PTT)

W91-01363

# **STRUCTURE-TOXICITY RELATIONSHIPS FOR SELECTED WEAK ACID RESPIRATORY UNCOUPLERS.**

Tennessee Univ., Knoxville. Coll. of Veterinary Medicine.

M. Cajina-Quezada, and T. W. Schultz.  
Aquatic Toxicology AQOTODG, Vol. 17, No. 3, p 239-251, September 1990. 3 fig, 3 tab, 34 ref.

Descriptors: \*Dyes, \*Organic acids, \*Phenols, \*Quantitative analysis, \*Toxicity, \*Toxicology, \*Water pollution effects, \*Weak acids, Bioassay, Biological studies, Data interpretation, Model studies, Regression analysis, Statistical models.

The relative biological response (log BR) for each of 30 select substitute phenols and anilines was evaluated using the 48-h *Tetrahymena pyriformis* population growth test system. Simple linear regression analysis of log BR versus log Kow (1-octanol/water partition coefficient) was used to formulate a quantitative structure-activity relationship (QSAR). The equation, log BR = 0.438 (log Kow) + 0.157; n = 27, r-squared = 0.933, s = 0.151, f = 348.02, is a highly predictive model. An evaluation of data on fathead minnow mortality for these same compounds shows a similar QSAR, log LC50 = -0.590(log Kow) - 3.247; n = 11, r-squared = 0.917, s = 0.287, f = 99.04. These relationships are the respective QSARs for the respiratory uncoupling mechanism of action of selected weak acids. Moreover, the toxic response in the two systems are highly correlated (r-squared = 0.915). (Author's abstract)

W91-01364

# **EFFECT OF CADMIUM ON VITELLOGENIN METABOLISM IN ESTRADIOL-INDUCED FLOUNDER (*PLATICHTHYS FLESUS* (L.)) MALES AND FEMALES.**

Odense Univ. (Denmark). Biological Inst.

A. F. Povlsen, B. Korsgaard, and P. Bjerregaard.  
Aquatic Toxicology AQOTODG, Vol. 17, No. 3, p 253-262, September 1990. 4 fig, 3 tab, 24 ref.

Descriptors: \*Cadmium, \*Fish physiology, \*Flounders, \*Vitellogenin, \*Water pollution effects, Bioaccumulation, Biological studies, Estradiol, Liver, Toxicity.

The hepatic synthesis of vitellogenin can be induced in male teleosts by treatment with estradiol. During vitellogenesis in nature the metabolic demand on the liver of the female teleost is very large, considering that the weight of the ovary may increase to one-fourth or more of the body weight due to vitellogenic growth of the oocytes. It is well established that cadmium accumulates in the liver and kidney of teleost fish and may induce synthesis of metallothioneins in the liver. One injection of 2 mg cadmium/kg body wt reduced the ratio of RNA to DNA in the liver to less than half of the control value and significantly depressed the concentration of vitellogenin in the plasma of estradiol-injected female flounders. A dose of 0.5 mg cadmium/kg body wt had no effect. In estradiol-induced flounder males cadmium treatment had a significant reducing effect on the level of circulating vitellogenin in the combined estradiol-cadmium treated group compared to the estradiol treated group. No effect of cadmium was observed on the ratio of hepatic RNA to DNA in the male fish. By gel fractionation, it was found that 88% of the accumulated cadmium in the cadmium estradiol treated group and only 49% in the cadmium treated group were bound to small cytosol proteins (metallothioneins) indicating that estradiol interferes with the cadmium accumulating ability of the liver. (Lantz-PTT)

W91-01365

# **METABOLIC RESPONSE OF GRASS SHRIMP *PALAEMONETES KADIakensis* RATHBUN, TO ACUTE EXPOSURE OF SUBLETHAL CHANGES IN PH.**

Texas A and M Univ., College Station. Dept. of Biology.

D. L. McCulloch.  
Aquatic Toxicology AQOTODG, Vol. 17, No. 3, p 263-274, September 1990. 4 fig, 1 tab, 49 ref.

Descriptors: \*Acid rain effects, \*Hydrogen ion concentration, \*Shrimp, \*Sublethal effects, \*Water pollution effects, Animal physiology, Bioassay, Biological studies, Oxygen, Stress, Toxicity.

The effects of sublethal changes in environmental pH on the grass shrimp *Palaemonetes kadiakensis* were determined using changes in metabolic rate and critical oxygen concentration as indicators of stress. Oxygen consumption was measured using a computer automated intermittent flow respirometer which allowed multiple sampling of a single individual without exposing it to prolonged oxygen stress. Metabolic rate and critical oxygen concentration were determined using a quadratic model with plateau nonlinear regression procedure. Sublethal changes in pH (6.5, 9.0) did not have a significant effect on metabolic rate. Temporary disturbances in hemolymph acid-base status caused by acute pH stress, may not elicit a metabolic response when not accompanied by necrosis of the gill epithelium. An effect of pH on the critical oxygen concentration was found. When the pH was 6.5, significantly higher than the control (pH 7.8), or 9.0, significantly lower than the control. Shifts in critical oxygen concentration were attributed to changes in blood oxygen affinity caused by hemolymph acidosis or alkalosis. (Author's abstract)

W91-01366

# **EFFECTS OF SUBLETHAL EXPOSURE TO CHLORINE ON THE UPTAKE OF POLYCHLORINATED BIPHENYL CONGENERS BY RAINBOW TROUT, *SALMO GAIARDNERI* (RICHARDSON).**

Tennessee Univ., Knoxville. Graduate Program in Ecology.

M. C. Black, and J. F. McCarthy.

Aquatic Toxicology AQOTODG, Vol. 17, No. 3, p 275-289, September 1990. 6 fig, 1 tab, 31 ref. DOE Contracts DE-AC06-76OR00033 and DE-AC05-84OR21400.

Descriptors: \*Chlorine, \*Polychlorinated biphenyls, \*Sublethal effects, \*Trout, \*Water pollution effects, Bioassay, Biological studies, Ecotoxicology, Fish physiology, Gills, Oxygen, Toxicity.

Chlorine-induced changes in fish gill histopathology and respiration may alter the uptake of contaminants which are accumulated by passive diffusion across gill membranes. The effect of chlorine exposure on gill histopathology, respiratory functions, and uptake of three polychlorinated biphenyl (PCB) congeners by rainbow trout (*Salmo gairdneri*) were determined. Trout gill lamellar lesions occurring during a 24-h exposure to 0.04 mg/L chlorine included proliferation of mucous cells, hyperplasia of epithelial cells, clubbed lamellae, and lamellar fusion. These types of pathological changes would be expected to result in increased diffusion distances of the gill membrane and decreased functional gill surface area. Reductions in oxygen and PCB uptake efficiencies measured in concomitant exposures to chlorine and PCBs using a fish metabolic chamber were consistent with the histopathological results. Increases in trout ventilation compensated for the lowered uptake deficiencies. As a result of ventilatory compensation, there was little change in the oxygen consumption for PCB accumulation by trout throughout the exposure to chlorine. Correlations between oxygen and PCB uptake may provide a basis for estimating toxicant uptake using oxygen uptake data as the basis for extrapolation. (Author's abstract)

W91-01367

# **PHYTOPLANKTON DYNAMICS IN THREE ROCKY MOUNTAIN LAKES, COLORADO, U.S.A.**

Geological Survey, Denver, CO.

D. M. McKnight, R. L. Smith, J. P. Bradbury, J. S. Baron, and S. Spaulding.  
Arctic and Alpine Research ATPAV, Vol. 22, No. 3, p 264-274, August 1990. 4 fig, 5 tab, 39 ref.

Descriptors: \*Acid rain effects, \*Limnology, \*Mountain lakes, \*Phytoplankton, \*Population dy-

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

namics, \*Water pollution effects, Algae, Algal blooms, Colorado, Nitrates, Photosynthesis, Rocky Mountains, Snowmelt.

In 1984 and 1985 seasonal changes in phytoplankton were studied in a system of three lakes in Loch Vale, Rocky Mountain National Park, Colorado, to determine the effects of urban atmospheric deposition. Three periods were evident: (1) A spring bloom, during snowmelt, of the planktonic diatom *Asterionella formosa*, (2) a midsummer period of minimal algal abundance, and (3) a fall bloom of the blue-green alga *Oscillatoria limnetica*. Seasonal phytoplankton dynamics in these lakes are controlled partially by the rapid flushing rate during snowmelt and the transport of phytoplankton from the highest lakes to the lower lakes by the stream, Icy Brook. During snowmelt, the *A. formosa* population in the most downstream lake has a net rate of increase of 0.34/d, which is calculated from the flushing rate and from the *A. formosa* abundance in the inflow from the upstream lake and in the downstream lake. Measurement of photosynthetic rates at different depths during the three periods confirmed the rapid growth of *A. formosa* during the spring. The decline in *A. formosa* after snowmelt may be related to grazing by developing zooplankton populations. The possible importance of seasonal variations in nitrate concentrations were evaluated in situ enrichment experiments. For *A. formosa* and *O. limnetica* populations, growth stimulation resulted from 8 or 16 micromolar amendments of calcium nitrate and sulfuric acid, but the reason for this stimulation could not be determined from these experiments. (Author's abstract)

W91-01368

**RELATIONSHIPS AMONG DEPTH TO FROZEN SOIL, SOIL WETNESS, AND VEGETATION TYPE AND BIOMASS IN TUNDRA NEAR BETHEL, ALASKA, U.S.A.**  
Gettysburg Coll., PA. Dept. of Biology.  
M. F. Gross, M. A. Hardisky, J. A. Doolittle, and V. Klemas.  
Arctic and Alpine Research ATLPAV, Vol. 22, No. 3, p 275-282, August 1990. 3 fig, 3 tab, 51 ref.  
NASA Biospheric Research Program Grant NAGW-374.

Descriptors: \*Air pollution effects, \*Alaska, \*Biomass, \*Frozen ground, \*Global warming, \*Soil water, \*Vegetation, Bethel, Soil environment, Tundra.

Investigators in this program participated in NASA's Biospheric Research Program Global Tropospheric Experiment (GTE) in Alaska in order to assess gas flux and vegetation characteristics of moist and wet tundra. Because wetland soils are often anaerobic, much of the organic carbon produced by wetland vegetation and buried when the vegetation dies decomposes under anoxic conditions. Among the gases released during decomposition is methane, a 'greenhouse gas' the concentration of which is increasing globally at the rate of about 1% per year. Wet tundra and its vegetation may play a major role in future biogeochemical cycling because there is a larger component of buried, partially decomposed organic matter in tundra soils, and because most models suggest that warming induced by the greenhouse effect will be relatively large in polar regions. The organic matter is not decomposing rapidly at present because of cold soil temperatures. In order to detect any future additional gas flux caused by greenhouse-effect warming, it is first necessary to have baseline data on current gas flux. Carbon sequestering through photosynthesis, and released through respiration, are strongly influenced by vegetation and temperature, including the effect of temperature on the depth of the biologically active layer. Therefore, changes in gas flux can, theoretically, be inferred by changes in vegetation condition (biomass or species distribution) or in depth of the thawed layer. Assessing changes in the tundra on a global scale will require the use of remote sensing to study vegetation and depth to frozen soil. Ground-penetrating radar (GPR) is a rapid, accurate way of measuring thickness of the active layer and depth to frozen soil remotely, while vegetation type can be surveyed for a large area of

tundra quickly using satellite imagery. If any consistent relationship exists among vegetation type, biomass, soil wetness, and depth to frozen soil in tundra in the Bethel region of southwestern Alaska, a remote sensing-based assessment of vegetation type or of depth to frozen soil could possibly be used as a predictor of gas flux. (Lantz-PTT)

W91-01369

### IMPLICATIONS OF AQUATIC ANIMAL HEALTH FOR HUMAN HEALTH.

Harvard Medical School, Boston, MA. Dept. of Pathology.  
C. J. Dawe.  
Environmental Health Perspectives EVHPAZ, Vol. 86, p 245-255, June 1990. 1 tab, 78 ref.

Descriptors: \*Aquatic animals, \*Environmental protection, \*Path of pollutants, \*Public health, \*Public policy, \*Water pollution effects, Environmental policy, Management planning, Policy making, Water pollution prevention.

Human health and aquatic animal health are organically related at three distinct interfaces. Aquatic animals serve as important contributors to the nutritional protein, lipid and vitamin requirements of humans; as carriers and transmitters of many infections and parasitic diseases; and as indicators of toxic and carcinogenic substances that they can convey, in some part from aquatic environments to humans and other terrestrial animals. Transcending these relationships, but less visible and definable to many, is the role that aquatic animals play in the sustenance of this integrated planetary ecosystem. The negative values of aquatic animals as disease vectors are far outweighed by their positive values as nutritional sources and as sustainers of a relatively stable equilibrium in the global ecosystem. In the immediate future, increased and improved monitoring of aquatic habitats can be expected to determine the extent to which aquatic animals cycle anthropogenic toxic and carcinogenic chemicals back to human consumers. In the long-term, methods are particularly needed to assess the effects of these pollutants on reproductive success in aquatic communities and in human communities as well. As inputs of habitat-degrading substances change in quality and quantity, it becomes increasingly urgent to evaluate the consequences in advance, not in retrospect. A new, more realistic and comprehensive philosophy regarding aquatic environmental preservation and equally new and comprehensive philosophy technological advances reflective of this philosophy will be required. (Lantz-PTT)

W91-01375

### FISH HEALTH AND ENVIRONMENTAL HEALTH.

National Marine Fisheries Service, Woods Hole, MA. Northeast Fisheries Center.  
R. A. Murchelano.  
Environmental Health Perspectives EVHPAZ, Vol. 86, p 257-259, June 1990. 22 ref.

Descriptors: \*Bioindicators, \*Biomonitoring, \*Cancer, \*Fish, \*Monitoring, \*Water pollution effects, Bioaccumulation, Boston Harbor, Flounders, Water quality.

Surveys conducted to evaluate the health of marine bottom fishes have been conducted in the eastern and western North Atlantic for the past 15 years, usually in conjunction with fish stock assessment cruises. The health of the fish sampled was evaluated using certain integumental and skeletal lesions and anomalies as markers to signify compromised health status. The results of these surveys indicate that fish health is poorer in coastal waters that have been anthropogenically degraded. Monitoring programs to determine the status and trends in levels in inorganic and organic contaminants in fish tissue and sediments have disclosed high levels of chemical contaminants in several coastal areas of the northern US. Histopathological examination of liver tissues of winter flounder, *Pseudopleuronectes americanus*, from Boston Harbor, one of the more chemically contaminated sites, has revealed a high prevalence of hepatocarcinoma. (Author's abstract)

W91-01376

### ALUMINUM IN DOMESTIC WATER: OVERLOAD MAY BE HAZARDOUS TO DIALYSIS PATIENTS.

Louisiana State Univ. Medical Center, Shreveport.  
K. Abreo, M. Sella, and S. T. Brown.  
Journal of Environmental Health JEVH, Vol. 52, No. 5, p 289-290, March/April 1990. 1 fig, 1 tab, 16 ref.

Descriptors: \*Aluminum, \*Dialysis, \*Domestic water, \*Kidneys, \*Louisiana, \*Public health, \*Water treatment, Clarification.

Since contamination of dialysis water can be a major source of aluminum accumulation, aluminum content was measured in domestic and dialysis water in all 59 dialysis units in Louisiana, and correlated with red cell indices, a reversible marker of aluminum overload. Findings suggest that aluminum sulfate added to domestic water as a coagulant was responsible for increased aluminum levels. Since high aluminum levels pose a potential risk to patients with renal failure, aluminum free chemicals should be used for water clarification. Results of this study suggest that there is an increased likelihood of high aluminum content in domestic or drinking water derived from slowly flowing or stagnant surface sources to which aluminum sulfate has been added for clarification. Water treatment facilities could lower aluminum content of water by utilizing non-aluminum containing coagulants. (Lantz-PTT)

W91-01382

### RELATIONS BETWEEN ACID RAIN AND VESICULAR-ARBUSCULAR MYCORRHIZA.

Utrecht Rijksuniversiteit (Netherlands). Dept. of Plant Ecology.  
B. Heijne, G. W. Heil, and D. van Dam.  
Agriculture, Ecosystems and Environment AEENDO, Vol. 29, No. 1-4, p 187-192, February 1990. 3 tab, 14 ref.

Descriptors: \*Acid rain effects, \*Air pollution effects, \*Fungi, \*Grasses, \*Nitrogen, \*Phosphorus, \*Potassium, \*The Netherlands, Nitrogen oxides, Sulfur dioxide, Vesicular-arbuscular mycorrhiza.

In the Netherlands, the air pollution of SO<sub>2</sub> and NO<sub>x</sub> generally increases from the northwest to the southeast. Plants from dry grass heathland (*Viola canina*) were sampled in May and at the end of September 1987, in both northern and southern Netherlands. Percentages of root length infected with vesicular-arbuscular mycorrhiza were calculated. Determination of nitrogen, phosphorus and potassium content of shoots and roots indicated there was a seasonal effect. In spring vesicular-arbuscular mycorrhiza infection was lower than at the end of the summer. Plants of *Viola canina*, which grew close to the border of an arable field (1-2 m), had a lower vesicular-arbuscular mycorrhiza infection than those growing in the center of the heath vegetation. No correlation was found between the amount of vesicular-arbuscular mycorrhiza infection and the amount of acid rain as determined by the National Institute of Public Health and Environmental Hygiene. (Author's abstract)

W91-01410

### TIME TREND OF PCB CONCENTRATIONS IN SURFACE SEDIMENTS FROM A HYPERTROPHIC, MACROALGAE POPULATED AREA OF THE LAGOON OF VENICE.

Venice Univ. (Italy). Dept. of Environmental Science.

For primary bibliographic entry see Field 5B.  
W91-01448

### LITHIUM IN DRINKING WATER AND THE INCIDENCES OF CRIMES, SUICIDES, AND ARRESTS RELATED TO DRUG ADDICTIONS.

California Univ., San Diego, La Jolla. Dept. of Chemistry.  
For primary bibliographic entry see Field 5F.  
W91-01483

## Effects Of Pollution—Group 5C

**PIRLA PROJECT (PALEOECOLOGICAL INVESTIGATION OF RECENT LAKE ACIDIFICATION): AN INTRODUCTION TO THE SYNTHESIS OF THE PROJECT.**

Indiana Univ. at Bloomington. Dept. of Biology.  
For primary bibliographic entry see Field 5B.  
W91-01498

**PALEOECOLOGICAL INVESTIGATION OF RECENT LAKE ACIDIFICATION IN THE ADIRONDACK MOUNTAINS, N.Y.**

Indiana Univ. at Bloomington. Dept. of Biology.  
For primary bibliographic entry see Field 5B.  
W91-01499

**UTILITY OF SCALED CHRYSOPHYTES FOR INFERRING LAKEWATER PH IN NORTHERN NEW ENGLAND LAKES.**

Queen's Univ., Kingston (Ontario). Dept. of Biology.  
For primary bibliographic entry see Field 2H.  
W91-01502

**THERMAL AND TROPIC STABILITY OF DEEPER MAINE LAKES IN GRANITE WATERSHEDS IMPACTED BY ACID DEPOSITION.**

Maine Univ. at Orono. Dept. of Geological Sciences.  
R. E. Stauffer, and B. D. Wittchen.  
Water Resources Research WRRQAQ, Vol. 26, No. 9, p 2143-2151, September 1990. 6 fig, 2 tab, 32 ref. OWRT Grant 5-6-44942.

Descriptors: \*Acid rain effects, \*Lake acidification, \*Limnology, \*Maine, \*Thermal stratification, \*Trophic level, \*Water pollution effects, \*Water pollution sources, Deep water, Granites, Hypolimnion, Oxygen deficit, Stratification, Transparency.

Acid deposition can lead to lake and watershed acidification, increases in lake transparency, and reductions in thermal stability and hypolimnetic oxygen deficits. On the basis of lake surveys during August-September 1985, it was determined to what extent the deeper (maximum depth > 17m) Maine lakes in acid-sensitive granitic watersheds have registered changes in temperature and oxygen stratification compared to the earliest scientific surveys of the state's lakes performed in 1938-1942. After correcting for small but geographically consistent interannual differences in summer hypolimnetic temperatures related to spring turnover, and weather-dependent differences in mixed layer depth, there has been no significant change in thermal stratification in these Maine lakes over approximately 43 years. On the basis of specific historical contrasts in the late summer metalimnetic, hypolimnetic, and bathylinnetic oxygen concentrations there has been no significant change in lake trophic state or transparency. (Author's abstract)  
W91-01530

**INDUCTION OF HEPATIC MIXED-FUNCTION OXIDASE OF THE MULLET, MUGIL SO-IUY BY CRUDE OIL (IN CHINESE).**

Academia Sinica, Qingdao (China). Inst. of Oceanology.  
F. Feng, and F. Y. Liu.  
Oceanologia et Limnologia Sinica (Hai Yang Yu Hu Chao) HYHCAG, Vol. 21, No. 2, p 192-195, March 1990. 1 tab, 8 ref. English summary.

Descriptors: \*Bioindicators, \*Enzymes, \*Fish physiology, \*Oil pollution, \*Water pollution effects, China, Fauna, Huaiquan Bay, Mullet, Qingdao.

Induction of hepatic aryl hydrocarbon hydroxylase (AHH), an enzyme, by crude oil in the liver of Magil so-iuy was used as a bioindicator. Magil so-iuy is a shore-dwelling fish which is found in Huaiquan Bay, Qingdao. The fish used in the study were captured in 1986. After 3 to 5 day's exposure in sea water with an oil concentration of 0.13-0.16 mg/L, enzyme activity increased by six to eight-fold in comparison with uninduced controls. After seven-days exposure or longer, the specific activity

of the enzyme reached maximum levels without obvious change. Magil so-iuy is a mullet with limited home range. It is, therefore, possible to use this organism to monitor for petroleum pollution by testing for hepatic AHH activity. (Author's abstract)  
W91-01573

**AUTOTROPHIC AND HETEROTROPHIC ATP POOLS IN MICROBIAL COMMUNITIES: SUGGESTIONS FOR SEPARATION AND FOR BACTERIAL GROWTH RATE EVALUATION.**

Parma Univ. (Italy). Ist. di Ecologia.  
For primary bibliographic entry see Field 5A.  
W91-01595

**SUBSTRATE-ECTOENZYME INTERACTION: SIGNIFICANCE OF BETA-GLUCOSIDASE ACTIVITY FOR GLUCOSE METABOLISM BY AQUATIC BACTERIA.**

Warsaw Univ. (Poland). Dept. of Environmental Microbiology.  
For primary bibliographic entry see Field 2H.  
W91-01597

**TRIBUTYL TIN AND INVERTEBRATES OF A SEAGRASS ECOSYSTEM: EXPOSURE AND RESPONSE OF DIFFERENT SPECIES.**

Cornell Univ., Ithaca, NY. Ecosystems Research Center.  
J. R. Kelly, D. T. Rudnick, R. D. Morton, L. A. Buttel, and S. N. Levine.  
Marine Environmental Research MERSDW, Vol. 29, No. 4, p 245-276, 1990. 8 fig, 5 tab, 38 ref, append. EPA Cooperative Agreement Nos. CR812685, CR812685-02, and CR812685-03.

Descriptors: \*Antifoulants, \*Bioaccumulation, \*Marine environment, \*Sea grasses, \*Tributyltin, \*Water pollution effects, Bioindicators, Carbon radioisotopes, Ecosystems, Invertebrates, Marine animals, Marine plants, Microenvironment, Radioactive tracers.

In shallow coastal waters certain dissolved or suspended particulate chemicals may become concentrated in seagrass beds. Tributyltin, released to marine waters from certain antifouling paints, has come under recent regulation because of high toxicity and growing use. (C14)-labeled tributyltin chloride (TBT-Cl) was delivered to the water column of seagrass (*Thalassia testudinum*) microcosms held in the laboratory under flow-through conditions. Benthic macroinvertebrate abundances across a three treatment logarithmic dose gradient were compared to untreated control microcosms. Within 3 to 6 weeks, statistically significant mortality appeared in the high treatment (22.2 microg/L). Sensitive species included surface deposit feeders of several phyla, as well as a suspension feeding mollusk. Results suggested that effects can arise because TBT is rapidly accumulated in surface sediments, as well as in *Thalassia* tissues. Concentration of tracer in plant tissues, animals, and sediments suggested that measurement of TBT (and total butyltin) in these components of seagrass beds would provide a better indicator of exposure regimes than occasional measurements in the water. A propensity for accumulation, along with a biological vulnerability, suggests a sentinel role for seagrass ecosystems in some shallow coastal areas. Experimental findings demonstrated concern for some key invertebrates within beds proximal to TBT sources, and ecological risks could radiate through webs dependent on these vegetated shallows. (Author's abstract)  
W91-01625

**ENVIRONMENTAL FACTORS AFFECTING BENTHIC INFAUNAL COMMUNITIES OF THE WESTERN ARABIAN GULF.**

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Research Inst.  
For primary bibliographic entry see Field 2L.  
W91-01626

**INTEGRATION OF LONG-TERM FISH KILL DATA WITH AMBIENT WATER QUALITY****MONITORING DATA AND APPLICATION TO WATER QUALITY MANAGEMENT.**

Post, Buckley, Schuh and Jernigan, Inc., Columbia, SC.  
A. H. Trim.  
Environmental Management EMNGDC, Vol. 14, No. 3, p 389-396, March/April 1990. 3 fig, 3 tab, 13 ref.

Descriptors: \*Coastal zone management, \*Estuarine fisheries, \*Fishkill, \*Monitoring, \*Pesticides, \*Statistical analysis, \*Water pollution effects, \*Water quality management, Coastal waters, Data interpretation, Water pollution sources.

Almost half (354) of all fish kills (805) in South Carolina, between 1978 and 1988 occurred in the coastal zone. These kills were analyzed for causative, spatial, and temporal associations as a distinct data set and integrated with ambient water quality monitoring data. Estuarine kills as a result of natural causes accounted for 42.8% followed by man-induced (35.1%) and undetermined causes (22.1%). Although general pesticide usage was responsible for 53.9% of man-induced kills, weed control activities around resorts and municipal areas accounted for slightly more kills (20.9%) than did agricultural (19.8%) or vector control (13.2%) uses. A dramatic decline in agricultural-related kills has been observed since 1986 when the integrated pest management approach was adopted by many farmers. When taken with the few kills (12.0%) resulting from wastewaters, this suggests that these two land-use activities have been successfully managed via existing programs (IPM and NPDES, respectively) to minimize their contributions to estuarine fish kills. Ambient trend monitoring data demonstrated no coastal-wide dispersion of pesticide pollution. These data confirmed the nature of fish kills to be site-specific, near-field events most closely associated with the contiguous land-use practices and intensities. Typically, fish kill data are considered as event-specific data related to that event only. This analysis has shown, however, that a long-term data set, when integrated with ambient water quality data, can assist in regulatory and resource management decisions for both short-term and long-term planning and protection applications. (Author's abstract)  
W91-01635

**LACK OF EFFECT OF DRINKING WATER BARIUM ON CARDIOVASCULAR RISK FACTORS.**

Cincinnati Univ., OH. Coll. of Medicine.  
For primary bibliographic entry see Field 5F.  
W91-01666

**INDUCTION OF ALKOXYRESORUFIN METABOLISM: A POTENTIAL INDICATOR OF ENVIRONMENTAL CONTAMINATION.**

Barcelona Univ. (Spain). Dept. of Microbiology.  
R. A. Lubet, F. P. Guengerich, and R. W. Nims.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 2, p 157-163, March/April 1990. 4 fig, 1 tab, 28 ref.

Descriptors: \*Alkoxyresorufin, \*Bioassay, \*Bioindicators, \*Water pollution effects, Biochemistry, Chlorinated hydrocarbons, DDT, Dioxins, Monitoring, Organic compounds, Pesticides, Polycyclic aromatic hydrocarbons, Rats.

Methods of biochemical monitoring of individual animals for exposure to environmental contaminants are of great potential use. The hepatic metabolism of various alkoxyresorufins, which are highly specific substrates for certain forms of cytochrome(s) P450, is highly induced by a variety of environmental contaminants. Thus, the *o*-dealkylation of pentoxy-, or benzyloxyresorufin was induced greater than 20-fold in the rat by alpha-hexachlorocyclohexane, 2,4,5,2',4',5'-hexabromobiphenyl, DDT and Aroclor-1254, while the metabolism of ethoxyresorufin was highly induced by 5,6-benzoflavone, 3,4,5,3',4',5'-hexabromobiphenyl and Aroclor-1254. Additionally, rats exposed to diets containing as little as 12 ppm DDT displayed > 5 fold increase in the rate of hepatic *o*-dealkylation of benzyloxyresorufin. Induction of the hepatic

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

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metabolism of these resorufin ethers in 9000 xg supernatant fractions taken from rats exposed to potential environmental contaminants may constitute a valuable diagnostic indicator of the presence of a variety of pollutants, including polycyclic aromatic hydrocarbons, organochlorine pesticides, polyhalogenated biphenyls and 2,3,7,8-tetrachlorodibenzo-p-dioxin. These results suggest the potential applicability of these substrates in detecting chemical contamination in the environment. (Author's abstract)  
W91-01685

#### EFFECTS OF TRIBUTYL TIN ON SURVIVAL, GROWTH, MORPHOMETRY, AND RNA-DNA RATIO OF LARVAL STRIPED BASS, MORONE SAXATILIS.

Maryland Univ., Solomons. Chesapeake Biological Lab.

A. E. Pinkney, L. L. Matteson, and D. A. Wright. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 2, p 235-240, March/April 1990. 2 fig, 5 tab, 28 ref.

Descriptors: \*Antifoulants, \*Bass, \*Pesticides, \*Toxicity, \*Tributyltin, \*Water pollution effects, Bioassay, Biological studies, Ecotoxicology, Larvae, Mortality, Nucleic acids.

Three experiments were conducted on the effects of tributyltin (TBT). In the first experiment, thirteen day old larvae were exposed to 0, 0.067, 0.766, or 2.284 micrograms TBT/L for six days. All larvae exposed to 2.24 micrograms/L died by day 5; exposure to 0.766 micrograms/L significantly reduced survival relative to controls (59.8% vs. 81.8%). Significant, concentration dependent decreases in body depth occurred in larvae exposed to 0.067 and 0.766 micrograms/L. In experiment 2, all 16 day old larvae exposed to 1.489 micrograms/L died by day 6. Survival, weight, and morphometry parameters were not significantly different in larvae exposed to 0, 0.052, or 0.444 micrograms/L for 7 days. Notochord length and dry weight decreased significantly in larvae exposed to 0.514 micrograms/L. Weight and morphometry parameters were more sensitive indicators of sublethal stress than RNA-DNA ratio. Maximum TBT concentrations reported in Chesapeake Bay marinas are likely to cause increased larval mortality. Longer term studies are needed to assess effects at <0.050 micrograms/L, which may be more representative of habitat conditions. (Author's abstract)  
W91-01687

#### EFFECTS OF ACID-MINE DRAINAGE ON THE CHEMICAL AND BIOLOGICAL CHARACTER OF AN ALKALINE HEADWATER STREAM.

Thomas Hunt Morgan School of Biological Sciences, Lexington, KY.

T. M. Short, J. A. Black, and W. J. Birge. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 2, p 241-248, March/April 1990. 3 fig, 3 tab, 46 ref. Kentucky Natural Resources Memorandum of Agreement No. 5429.

Descriptors: \*Acid mine drainage, \*Benthic fauna, \*Heavy metals, \*Water pollution effects, Aluminum, Biological studies, Chemical analysis, Chubs, Copper, Fish, Headwaters, Hydrogen ion concentration, Iron, Kentucky, Manganese, Midges, Zinc.

Distribution of metals in water and sediments, as well as spatial alteration in benthic macroinvertebrate and fish assemblages, was assessed in an alkaline headwater stream in eastern Kentucky receiving runoff from an abandoned surface mine. Concentrations of aluminum, copper, iron, manganese, and zinc generally increased 2 to 3 orders of magnitude in the receiving water immediately below where the mine runoff entered the creek. Metals in the water column were transported downstream largely in association with suspended particulates, and declined in concentration progressively in a linear fashion commensurate to distance below the mine drainage outfall. In contrast, metal enrichment of sediments occurred spatially in a non-incremental pattern and varied among locations in conjunction with site specific changes in

concentration levels of sediment organic matter. Benthic macroinvertebrate and fish fauna were eliminated for a distance of 0.3 km below the outfall, presumably owing to the presence of high levels of dissolved metals and low pH. Recovery of stream benthos occurred 1.0-2.0 km further downstream and was characterized by numerical dominance of collector-gatherer trophic groups consisting primarily of midge larvae (Chironomidae: Orthocladini). Fish fauna in downstream reaches consisted exclusively of creek chubs (Semotilus atromaculatus) and stoneroller minnows (Campostoma anomalum). Metal levels in water and sediments remained elevated in regions of biological recovery and, as a consequence, downstream communities were comprised predominantly of metal tolerant taxa. (Author's abstract)  
W91-01688

#### USE OF THE MUSSEL WATCH AND MOLECULAR MARKER CONCEPTS IN STUDIES OF HYDROCARBONS IN A TROPICAL BAY (TODOS OS SANTOS, BAHIA, BRAZIL).

Centro de Investigacion y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry. For primary bibliographic entry see Field 5A.  
W91-01690

#### EFFECTS OF PESTICIDES ON SOME BIOCHEMICAL PARAMETERS OF CARP (CYPRINUS CARPIO L.).

Jozsef Attila Univ., Szeged (Hungary). Dept. of Biochemistry. B. Asztalos, J. Nemcsok, I. Benedekzy, R. Gabriel, and A. Szabo. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 2, p 275-282, March/April 1990. 12 fig, 1 tab, 34 ref.

Descriptors: \*Biochemistry, \*Carp, \*Pesticides, \*Water pollution effects, Biological studies, Copper sulfate, Enzymes, Fish physiology, Liver, Methidathion, Paraquat, Tissue analysis.

Treatments with copper sulfate (CuSO<sub>4</sub>), paraquat (PQ) and methidathion (MD) caused tissue damage and stress effects in carp. These effects were indicated by increased lactate dehydrogenase (LDH), glutamic oxaloacetic transaminase (GOT), and glutamate dehydrogenase (GIDH) enzyme activities and elevated blood sugar levels. Copper sulfate, administered together with PQ and MD, was synergistic in terms of tissue damage and stress effects. Isoenzyme patterns showed organ-specific tissue damage, and the administered chemical and isoenzymes indicating liver damage were detectable in the blood. The combination of CuSO<sub>4</sub> and MD caused local cell necrosis, which was observable in the liver tissue by light microscopy. Electron microscopic studies revealed the presence of damaged parenchymal cells with electron transparent cytoplasm, myelin figures, and altered mitochondria ER and Golgi. (Author's abstract)  
W91-01691

#### CO<sub>2</sub> CLIMATE SENSITIVITY AND SNOW-SEA-ICE ALBEDO PARAMETERIZATION IN AN ATMOSPHERIC GCM COUPLED TO A MIXED-LAYER OCEAN MODEL.

National Center for Atmospheric Research, Boulder, CO.

G. A. Meehl, and W. M. Washington. Climatic Change CLCHDX, Vol. 16, No. 3, p 283-306, June 1990. 11 fig, 23 ref.

Descriptors: \*Albedo, \*Carbon dioxide, \*Climatology, \*Data interpretation, \*Global warming, \*Model studies, Air temperature, Computer models, Ice, Oceans, Snow, Temporal variation.

A model (altered from a revised 1984 version) is run to equilibrium for 1 X CO<sub>2</sub> and 2 X CO<sub>2</sub> experiments. The 1 X CO<sub>2</sub> (control) simulation produces a global mean climate (GCM) that is about 1 degree warmer than the original version, and sea ice extent is reduced. The model with the altered parameterization displays heightened sensitivity in the global means, but the geographical patterns of climate change due to increased CO<sub>2</sub> are quantitatively similar. The magnitude of the

climate change is affected not only in areas directly influenced by snow and ice changes, but also in other regions of the globe, including the tropics where sea surface temperature, evaporation and precipitation over the oceans is greater. With the less sensitive formulation, the global mean surface air temperature increase is 3.5 C and the increase of global mean precipitation is 7.12%. The revised formulation produces a globally averaged surface air temperature increase of 4.04 C and a precipitation increase of 7.25%, as well as greater warming of the upper tropical troposphere. Sensitivity of surface hydrology is qualitatively similar between the two cases with the larger magnitude changes in the revised snow and ice-albedo scheme experiment. Variability of surface air temperature in the model is comparable to observations in most areas except in high latitudes during winter. In those regions, temporal variation of the sea-ice margin and fluctuations of snow cover dependent on the snow ice-albedo formulation contribute to larger than observed temperature variability. This study highlights an uncertainty associated with results from current climate GCMs that use highly parameterized snow-sea-ice albedo schemes with simple mixed layer ocean models. (Author's abstract)  
W91-01694

#### RELATIONSHIP BETWEEN WATER QUALITY AND CADDISFLY ASSEMBLAGE STRUCTURE IN FAST-RUNNING RIVERS, THE RIVER CADAGUA BASIN.

Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.

For primary bibliographic entry see Field 5A.  
W91-01697

#### OBSERVATIONS ON OVERWINTERING JUVENILE CHINOOK SALMON (ONCORHYNCHUS Tshawytscha) EXPOSED TO BLEACHED KRAFT MILL EFFLUENT IN THE UPPER FRASER RIVER, BRITISH COLUMBIA.

Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.

For primary bibliographic entry see Field 5B.  
W91-01724

#### COMPARATIVE TOXICITY OF SOLVENT YELLOW 33 (2-(2'-QUINOLINYL)-1,3-INDANEDIONE) AND SOLVENT GREEN 3 (1,4-DI-P-TOLUIDINO-ANTHRAQUINONE) DYES TO FRESHWATER ORGANISMS.

Johns Hopkins Univ., Shady Side, MD. Environmental Sciences Group.

D. T. Burton, D. J. Fisher, and R. L. Paulson. Chemosphere CSMHAF, Vol. 19, No. 12, p 1959-1970, 1989. 2 fig, 4 tab, 15 ref. U.S. Army Biomedical Research and Development Laboratory, Fort Detrick, Maryland Contract 85MM5505.

Descriptors: \*Aquatic life, \*Bioassay, \*Dyes, \*Toxicity, \*Water pollution effects, Algae, Amphipods, Aquatic insects, Comparison studies, Crustaceans, Fish, Invertebrates, Midges, Solvent green 3, Solvent yellow 33, Waterfleas.

The toxicity of Solvent Yellow 33 and Solvent Green 3 mixtures used as components of smoke munitions by the military was studied. The acute toxicity of the dyes to an array of nine freshwater aquatic organisms from various trophic levels was determined. Fish exposed to the two dyes for 96 h included the fathead minnow (Pimephales promelas), bluegill (Lepomis macrochirus), channel catfish (Ictalurus punctatus) and rainbow trout (Salmo gairdneri). Invertebrates, which were exposed for 48 h, included the water flea (Daphnia magna), amphipod (Gammarus pseudolimnaceus), midge larva (Paratanytarsus parthenogeneticus) and the mayfly larva (Hexagenia bilineata). Growth of the green alga Selenastrum capricornutum was also determined for both dyes. Solvent Yellow 33 and a Solvent Green 3 mixture (30:70 mixture of Solvent Yellow 33 and Solvent Green 3) were not acutely toxic to seven of nine freshwater species when tested at the solubility limits of the dyes in freshwater. A solubility limit solution of the Solvent

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Green 3 mixture killed 50% of the rainbow trout tested for 96 hr but was nontoxic when diluted by 50%. Both dyes caused a reduction in green algal growth at solubility limits. The Solvent Green 3 mixture was the most detrimental causing a 98-99% reduction in growth after 5 days of exposure. (Agostine-PTT)  
W91-01730

**EVALUATION OF THE POTENTIAL FOR TOXICS EXPOSURE IN THE GREAT LAKES REGION USING STORED DATA.**  
George Mason Univ., Fairfax, VA. Dept. of Biology.  
For primary bibliographic entry see Field 5B.  
W91-01732

**POPULATION EXPOSURE TO CHLOROPHENOLS, DIBENZO-P-DIOXINS AND DIBENZOFURANS AFTER A PROLONGED GROUND WATER POLLUTION BY CHLOROPHENOLS.**  
National Public Health Inst., Kuopio (Finland). Dept. of Environmental Hygiene and Toxicology.  
For primary bibliographic entry see Field 5B.  
W91-01734

**STREAMWATER ACIDIFICATION IN RELATION TO ACID PRECIPITATIONS—VEGETATION AND BEDROCK INFLUENCES, CONSEQUENCES FOR TROUT POPULATIONS: THE VOSGES MASSIF CASE STUDY (ACIDIFICATION DES EAUX DE SURFACE SOUS L'INFLUENCE DES PRÉCIPITATIONS ACIDES: RÔLE DE LA VÉGÉTATION ET DU SUBSTRATUM, CONSÉQUENCES POUR LES POPULATIONS DE TRUITES, LE CAS DES RUISSEAUX DES VOSGES).**  
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.  
A. Probst, J.-C. Massabau, J.-L. Probst, and B. Fritz.  
Comptes Rendus de l'Academie des Sciences (Serie 2) CRASEV, Vol. 311, No. 3, p 405-411, August 1990. 3 fig, 1 tab, 13 ref. English summary.

Descriptors: \*Acid rain, \*Acid rain effects, \*Acid streams, \*Mountain streams, \*Trout, \*Vegetation effects, \*Vosges (mountains), Aluminum, Bedrock, Buffer capacity, Drinking water, France, Soil types.

The acidification state of 39 streams in the Vosges massif was studied. Streamwaters were sampled twice under two contrasting hydrological conditions: autumn low water (period 1) and spring snow-melting (period 2). The streams were separated into five groups according to their chemical composition (using both cations and anions). It is noted that of the 39 streams sampled, 11 are really acid and 21 lose all buffering capacity during snow-melting and are very sensitive to the influence of acid atmospheric input. The 11 acid streams are located on the western side of the Vosges. A clear relationship has been indicated between the lack of trout and the stream acidification. The presence of trout appears to be limited by a pH value lower than 5.6 and by Al concentration higher than 180-200 ppb/L. The maximum Al concentration reaches 475 ppb/L during snow-melt. These values are distinctly higher than EEC tolerance limits for drinking water. The impact of acid atmospheric inputs on soils which are already acid and poor in exchangeable bases (podzolic series), and on sensitive bedrocks, has certainly led to stream acidification and hence to trout disappearance. (Agostine-PTT)  
W91-01738

**EFFECT OF SUBMERSED AQUATIC VEGETATION ON PHYTOPLANKTON AND WATER QUALITY IN THE TIDAL FRESHWATER POTOMAC RIVER.**  
George Mason Univ., Fairfax, VA. Dept. of Biology.  
For primary bibliographic entry see Field 2H.  
W91-01743

**INTERACTIONS BETWEEN BACILLUS THURINGIENSIS SUBSP. ISRAELENSIS AND FATHEAD MINNOWS, PIMPHALES PROMELAS RAFINESQUE, UNDER LABORATORY CONDITIONS.**  
Environmental Research Lab.-Duluth, MN.  
For primary bibliographic entry see Field 5B.  
W91-01759

**ISOLATION AND CHARACTERIZATION OF HEPATOTOXIC MICROCYSTIN HOMOLOGS FROM THE FILAMENTOUS FRESHWATER CYANOBACTERIUM NOSTOC SP. STRAIN 152.**  
Helsinki Univ. (Finland). Dept. of Microbiology.  
For primary bibliographic entry see Field 2H.  
W91-01761

**EFFECTS OF LIGHT, TEMPERATURE, NITRATE, ORTHOPHOSPHATE, AND BACTERIA ON GROWTH OF AND HEPATOTOXIN PRODUCTION BY OSCILLATORIA AGARDII STRAINS.**  
Helsinki Univ. (Finland). Dept. of Microbiology.  
For primary bibliographic entry see Field 5B.  
W91-01762

**FATE OF MACROZOOBENTHOS IN HYPER-TROPHIC LAKES: IN SITU REARING EXPERIMENTS WITH THE LARVAE OF TOKUNAGAYUSURIKA AKAMUSI (CHIRONOMIDAE).**  
National Inst. for Environmental Studies, Ibaraki (Japan). Environmental Biology Div.  
Takamura, and T. Iwakuma.  
Archiv fuer Hydrobiologie AHYBA4, Vol. 119, No. 1, p 65-78, July 1990. 6 fig, 1 tab, 31 ref.

Descriptors: \*Eutrophic lakes, \*Eutrophication, \*Japan, \*Midges, \*Sedimentation rates, \*Water pollution effects, Anaerobic conditions, Benthos, Biomass, Lake sediments, Larvae.

Larval chironomid, Tokunagayusurika akamusi, were reared in submerged glass bottles in Lakes Teganuma and Kasumigaura, central Japan. The larvae neither grew nor survived in very hypertrophic Lake Teganuma, though they grew and survived well in the less hypertrophic Lake Kasumigaura. Anaerobic conditions of the sediment in the rearing bottles of Lake Teganuma, which were induced by high sedimentation rates of newly deposited matter, were responsible for the complete mortality of the larvae. Anaerobic conditions were also observed in the sediment surface of Lake Teganuma. It was suggested that even in shallow lakes fully circulated by wind, hypertrophic conditions accompanied by massive primary production may depress macrozoobenthos biomass through anaerobic conditions in the lake-bottom sediments. (Author's abstract)  
W91-01769

**IMPROVED DETECTION OF ACID MINE WATER STRESSED COLIFORM BACTERIA ON MEDIA CONTAINING CATALASE AND SODIUM PYRUVATE.**  
West Virginia Univ., Morgantown. Div. of Plant and Soil Sciences.  
For primary bibliographic entry see Field 5A.  
W91-01770

**RESPONSE OF ATTACHED BACTERIA TO ZINC IN ARTIFICIAL STREAMS.**  
Indiana Univ.-Purdue Univ. at Fort Wayne. Dept. of Biological Sciences.  
D. Dean-Ross.  
Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 8, p 561-566, August 1990. 5 fig, 2 tab, 23 ref.

Descriptors: \*Aquatic bacteria, \*Path of pollutants, \*Species diversity, \*Water pollution effects, \*Zinc, Heavy metals, Resistance, Streams, Tolerance, Toxicity.

To study the response of natural communities of attached bacteria to Zn, artificial streams were

dosed with Zn at levels of 0, 0.01, 0.1, 0.5, 1.0, and 10.0 mg/L in duplicate treatment groups. Changes in total biomass, chlorophyll a content, total bacterial numbers, and heterotrophic activity were measured over a 5-week exposure period. The adaptation of the culturable bacterial community to Zn was assessed by comparing viable counts on unsupplemented medium with counts on media supplemented with several concentrations of Zn. The structure of that portion of the bacterial community capable of growth on nutrient agar was assessed by characterizing randomly selected colonies with respect to 20 nutritional capabilities and grouping the strains by numerical taxonomy. Streams receiving 0.5, 1.0, and 10.0 mg Zn/L were significantly inhibited with respect to all variables studied when compared with streams receiving 0, 0.01, or 0.1 mg Zn/L. Bacteria developed tolerance to the exposure concentration of Zn but were resistant to higher Zn concentrations. Increasing concentrations of Zn produced alterations in the structure of the culturable bacterial community, resulting in differing assemblages of bacterial groups and a decrease in diversity as measured by the Shannon-Wiener index and rarefaction. These results suggest that streams receiving 0.5 mg Zn/L or more may be adversely impacted. (Author's abstract)  
W91-01772

**INFLUENCE OF PH ON THE ACCUMULATION OF TRI-N-BUTYL TIN CHLORIDE AND TRIPHENYL TIN CHLORIDE IN CARP.**  
Shiga Prefectural Inst. of Public Health and Environmental Science, Otsu (Japan).  
For primary bibliographic entry see Field 5B.  
W91-01774

**EFFECTS OF INGESTED CRUDE OIL ON THYROID HORMONES AND ON THE MIXED FUNCTION OXIDASE SYSTEM IN DUCKS.**  
Trondheim Univ. (Norway). Dept. of Zoology.  
B. M. Jensen, M. Ekker, and K. Zahlsen.  
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 95, No. 2, p 213-216, 1990. 3 tab, 37 ref.

Descriptors: \*Ducks, \*Hormones, \*Oil pollution, \*Thyroid, \*Toxicology, \*Water pollution effects, Ecological effects, Enzymes, Metabolism, Oil.

Ingestion of Statfjord A crude oil from the North Sea has no apparent effect on the metabolic rate of ducks according to previous studies. This may be because this particular oil does not affect plasma concentrations of thyroid hormones and enzyme activities in the mixed function oxidase (MFO) system of ducks. To test this hypothesis, plasma concentrations of thyroid hormones (thyroxine and triiodothyronine), and levels of hepatic cytochrome P-450 and enzyme activities (NADPH cytochrome C reductase and GSH-S-transferase) in the MFO system were measured in domestic ducks (Anas platyrhynchos) which had ingested this crude oil. Daily oral dosing of 5 ml crude oil/kilogram body weight for 6 consecutive days resulted in a 53% increase in plasma triiodothyronine concentration and a 56% increase in the hepatic cytochrome P-450 level. The changes in these parameters were apparently not sufficient to cause any rise in metabolic heat production. This apparent contradiction is probably because activation of the MFO-system is energetically inexpensive. Also, possible metabolic effects caused by increased plasma-triiodothyronine concentration and activation of the MFO-system may have been masked by an inhibitory effect of the crude oil on mitochondrial electron transport and coupled phosphorylation. (Author's abstract)  
W91-01775

**EFFECT OF HEAVY METALS ON THE SEROTONIN AND DOPAMINE SYSTEMS IN THE CENTRAL NERVOUS SYSTEM OF THE FRESHWATER MUSSEL (ANODONTA CYGNEA L.).**  
Balatoni Limnologiai Kutató Intézet, Tihany (Hungary).  
For primary bibliographic entry see Field 5B.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

W91-01776

#### EFFECTS OF WATER-BORNE CADMIUM ON PLASMA CORTISOL AND GLUCOSE IN THE CICHLID FISH OREOCHROMIS MOSSAMBICUS.

Dar es Salaam Univ. (Tanzania). Dept. of Zoology and Marine Biology.  
H. B. Pratap, and S. E. Wendelaar Bonga.  
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 95, No. 2, p 313-317, 1990. 48 ref.

Descriptors: \*Cadmium, \*Cichlid, \*Glucose, \*Stress analysis, \*Tilapia, \*Toxicology, \*Water pollution effects, \*Adaptation, Ecological effects, Fish, Heavy metals, Toxicity.

Freshwater cichlids *Oreochromis mossambicus* (tilapia) were exposed to 10 micrograms Cd/L in ambient water for 2, 4, 14, and 35 days. Plasma cortisol and glucose levels were determined to evaluate if cadmium induced a typical stress response in these fish. Exposure to cadmium for 2, 4, and 14 days elicited a significant elevation of plasma cortisol levels. A significant hyperglycemia occurred on days 2 and 4 in cadmium-exposed fish. During long-term exposure to cadmium (35 days), the plasma cortisol and glucose levels returned to control values. This recovery after 35 days indicates the ability of tilapia to adapt to low cadmium concentrations in the ambient water. (Author's abstract)

W91-01777

#### MORPHOLOGICAL DEFORMITIES IN CHIRONOMIDAE(DIPTERA) LARVAE FROM THE LAC ST. LOUIS AND LAPRAIRIE BASINS OF THE ST. LAWRENCE RIVER.

National Hydrology Research Inst., Saskatoon (Saskatchewan).  
W. F. Warwick.

Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 185-208, 1990. 9 tab, 8 fig, 42 ref.

Descriptors: \*Aquatic insects, \*Heavy metals, \*Midges, \*Polychlorinated biphenyls, \*St Lawrence River, \*Toxic wastes, \*Water pollution effects, Benthos, Ecological effects, Larvae, Species diversity, Wastewater pollution, Water pollution sources.

Morphological deformities in chironomid communities were compared with indices of chemical contamination in the Lac St. Louis and Laprairie Basins of the St. Lawrence River. The most severely deformed larvae in Lac St. Louis were found in close proximity to the industrial complex around Beauharnois, Quebec, an area known to be seriously contaminated by polychlorinated biphenyls and heavy metals. Further away, and particularly in areas shielded from the main flow of the St. Lawrence by the Iles de la Paix complex, the frequency and severity of deformities decreased. Interpretation of contaminant responses was less easily accomplished in the Laprairie basin where the introduction of untreated domestic sewage imposed extremely severe environmental conditions for benthos. Comparison of contemporary and subsocial community diversities indicated that extensive changes have taken place in the structure of these communities in recent times. The presence of deformities in contemporary chironomid communities suggests that these changes have been brought about by chemical contaminants. (Author's abstract)

W91-01790

#### EFFECTS OF VARIOUS BIOPHYSICO-CHEMICAL CONDITIONS ON TOXIGENICITY OF VIBRIO CHOLERAE 01 DURING SURVIVAL WITH A GREEN ALGA, RHIZOCLONIUM PONTANUM, IN AN ARTIFICIAL AQUATIC ENVIRONMENT.

London School of Hygiene and Tropical Medicine (England). Dept. of Tropical Hygiene.  
For primary bibliographic entry see Field 2H.

W91-01801

#### EFFECTS OF ACIDIFICATION ON LEAF DECOMPOSITION IN STREAMS.

Oak Ridge National Lab., TN. Environmental Sciences Div.  
P. J. Mulholland, A. V. Palumbo, J. W. Elwood, and A. D. Rosemond.

Journal of the North American Benthological Society JNASEC, Vol. 6, No. 3, p 147-158, September 1987. 5 fig, 3 tab, 35 ref. Electric Power Research Institute Contract No. RP2326-1 and U.S. DOE Contract No. DE-AC05-84OR21400.

Descriptors: \*Acid rain effects, \*Acid streams, \*Acidification, \*Aluminum, \*Decomposing organic matter, \*Decomposition, \*Leaves, \*Mountain streams, \*Water pollution effects, Biomass, Carbon, Hydrogen ion concentration, Leaf decomposition, Microbial degradation, Microorganisms, Nitrogen, Phosphorus, Streams, Water chemistry.

Effects of acidification on leaf decomposition in streams were studied in four second-order streams in the Great Smokey Mountains National Park. The streams ranged in pH from 4.5 to 6.4 at baseflow. Mass loss of leaves incubated in mesh bags placed in pools in each stream was measured periodically over 15 wk beginning in late August. Measurements were also made of C, N, P, and Al in leaves, microbial biomass (adenosine triphosphate (ATP)) and respiration rate and bacterial production (thymidine uptake) associated with leaves, and the number and biomass of macroinvertebrates in leaf bags. Rates of leaf mass loss were significantly lower in streams with pH less than or equal to 5.7 compared with a stream with a pH of 6.4. Although rate of leaf mass loss among the streams varied directly with pH, differences between streams with pH values between 4.5 and 5.7 were not significant. Microbial ATP and respiration rates and bacterial production rates followed the same pattern as leaf mass loss rate, i.e., low for more acidic streams and highest in the stream with the highest pH. Accumulation of aluminum by the leaf-microbe complex was also greatest in the most acidic streams. The number and biomass of macroinvertebrates shredders found in leaf bags was lowest at the highest pH site and therefore cannot account for the higher rate of leaf mass loss found at this site. The results suggest that the lower rate of leaf decomposition in the more acidic streams is due largely to low rates of microbial activity. (Author's abstract)

W91-01803

#### FATE AND EFFECTS OF PULP MILL CHLOROPHENOLIC 4,5,6-TRICHLOROGUAIACOL IN A MODEL BRACKISH WATER ECOSYSTEM.

Swedish Environmental Research Inst., Karlskrona.

For primary bibliographic entry see Field 5B.

W91-01816

#### TENTATIVE IDENTIFICATION OF ORGANIC COMPOUNDS AT THE WESTSIDE WASTEWATER TREATMENT PLANT (HIGH POINT, NC) AND IMPLICATIONS FOR AQUATIC TOXICITY.

North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.

For primary bibliographic entry see Field 5D.

W91-01826

#### INVERTEBRATE COMMUNITIES OF SMALL STREAMS IN NORTHEASTERN WYOMING.

Geological Survey, Cheyenne, WY. Water Resources Div.

For primary bibliographic entry see Field 2H.

W91-01850

#### ACIDIFICATION IN NORWAY - LOSS OF FISH POPULATIONS AND THE 1000 LAKE SURVEY 1986.

Norsk Inst. for Vannforskning, Oslo.  
B. O. Rosseland, and A. Henriksen.  
Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 45-56, July 1990. 8 fig, 29 ref.

Descriptors: \*Acid rain effects, \*Fish populations, \*Fishkill, \*Lakes, \*Norway, \*Water pollution effects, Acidic water, Aluminum, Chemistry of pre-

cipitation, Deposition, Lake restoration, Nitrates, Sulfur compounds, Surveys, Water pollution.

Several regional surveys have demonstrated that lakes and watersheds in Norway are affected by acid precipitation. In autumn of 1986, the Norwegian Institute for Water Research (NIVA) conducted the 1000-Lake Survey on behalf of the Norwegian State Pollution Control Authority (SFT). The greatest loss of freshwater fish populations was found in Telemark, East Agder, West Agder, and Rogaland counties. This damage correlated well with pH and the concentrations of calcium and labile aluminum in the lakes. The number of barren lakes in Sorlandet and southern Vestlandet has doubled from 1971 to 1975. The chemical changes were characterized by a decrease in calcium and sulfate and an increase in aluminum and nitrate. There was little change in pH. The total land area affected by acidification damage increased from 33000 sq km in 1974 to 1979 to 36000 sq km in 1986. In 1986, over 18000 sq km were totally damaged compared with 13000 sq km in 1974 to 1979. This reflects an increase of nearly 40%. The greatest increase was registered in eastern Norway. Data from the 1000-Lake Survey indicated that 52% of the lakes in southern Norway were endangered. A 30% reduction in loadings of sulfur compounds would lead to the restoration of 28% of these lakes. A further reduction of 50% would ensure viable conditions for fish in 49% of the lakes, given a constant nitrate level in the lakes. The data provides hope for improving the environmental conditions of Norway's lakes. (Author's abstract)

W91-01889

#### ACID PRECIPITATION: BIOLOGICAL MONITORING OF STREAMS AND LAKES.

Bergen Univ. (Norway). Zoological Museum.

For primary bibliographic entry see Field 5A.

W91-01890

#### ALUMINUM MOBILIZATION IN SOIL AND STREAM WATERS AT THREE NORWEGIAN CATCHMENTS WITH DIFFERENT ACID DEPOSITION AND SITE CHARACTERISTICS.

Senter for Industriforskning, Oslo (Norway).

For primary bibliographic entry see Field 5B.

W91-01895

#### EFFECTS OF TRIBUTYL TIN WITHIN A THALASSIA SEAGRASS ECOSYSTEM.

Cornell Univ., Ithaca, NY. Ecosystems Research Center.

J. R. Kelly, S. N. Levine, L. A. Buttel, K. A. Carr, and D. T. Rudnick.

Estuaries ESTUDO, Vol. 13, No. 3, p 301-310, September 1990. 1 fig, 6 tab, 18 ref. EPA Cooperative Agreement Nos. CR811649, CR812685, CR812685-02, and CR812685-03.

Descriptors: \*Antifoulants, \*Sea grasses, \*Tributyltin, \*Water pollution effects, Bioassay, Biological studies, Biomass, Carbon radioisotopes, Chlorophyll, Detritus, Mortality, Tributyltin chloride.

Flow-through seagrass core microcosms were used to examine responses of species and processes to a logarithmic gradient of dosing with <sup>14</sup>C labeled tributyltin-chloride (TBT-CL). Experiments involved delivery of TBT-CL to the water column of replicate cores of a treatment (n = 16) once per week; one-half of the cores were sacrificed after three weeks of dosing, the others were dosed for 6 weeks. Initial water column concentrations for the three treatments averaged 0.205, 2.23, and 22.21 micrograms/L, expressed as TBT+ cation, but these concentrations dropped rapidly. Retained <sup>14</sup>C tracer, an estimate of total organotin species, was distributed to sediments, plants and other biological tissues, all of whose tracer concentrations increased with time. Measures to indicate responses of both autotrophic and heterotrophic organisms were made; in general, treatment effects were demonstrable statistically only at the highest dose level. Accumulation of chlorophyll and biomass on glass slides was highest when suspended for the entire experiment in the water of the high-

## Effects Of Pollution—Group 5C

est treatments; this unexpected result was perhaps an indirect effect related to reduced grazing activity in the microcosms. The highest dose of TBT-CL resulted in a virtual population mortality of a few macrobenthic species and decreased loss of plant material in litter bags, both demonstrated within the first 3 weeks of dosing. Reduced litter loss was coincident with mortality of an amphipod (*Cymadusa compta*) capable of shredding plant material, and a causal relation between the two effects is plausible. Thus, if concentrated to similar levels in a *Thalassia* bed, TBT+ may have direct species-level effects and process-level effects, potentially causing ecosystem changes via disruption of a species-process linkage influential in seagrass detrital food web dynamics. (Author's abstract) W91-01906

**RECRUITMENT FAILURE OF THE BAY SCALLOP, ARGOPECTEN IRRADIANS CONCENTRICUS, DURING THE FIRST RED TIDE, PTYCHODISCUS BREVIS, OUTBREAK RECORDED IN NORTH CAROLINA.**  
North Carolina Univ., Morehead City. Inst. of Marine Sciences.  
H. C. Summerson, and C. H. Peterson.  
Estuaries ESTUD, Vol. 13, No. 3, p 322-331, September 1990, 3 figs, 5 tab, 25 ref. Department of Commerce Federal Grant NA86AA-D-SG046, Project R/MRD-6.

Descriptors: \*Estuaries, \*North Carolina, \*Red tide, \*Scallops, \*Water pollution effects, Back Sound, Bogue Sound, Core Sound, Ecosystems, Fisheries, Mortality, Population dynamics, Seasonal variation.

In the presence of the first recorded red tide (*Ptychodiscus brevis*) outbreak in North Carolina (autumn 1987) recruitment of bay scallops (*Argopecten irradians concentricus*) in the state's most productive scallop beds was a virtual failure. Recruitment averaged across all of Bogue Sound and Back Sound was only 2% of the mean of three previous red tide-free (control) years. Only from central Core Sound northward, where the red tide occurred later and not as intensively, was bay scallop recruitment normal (93% of control years). Mortality of adult scallops from early December 1987 to late January 1988, while red tide was at bloom concentrations but fishing was prohibited, was 21%. No comparable natural mortality data exist for control years because intense fishing mortality in this period is confounded with natural mortality. Data on abundance of articulated pairs of empty shells strongly suggest that the red tide caused mortality of both adult and newly recruited bay scallops. Bay scallop recruitment in autumn 1988 again failed to restock the traditionally productive scallop beds in western Bogue Sound and in Back Sound, perhaps because the only concentrations of spawners surviving the red tide in central Core Sound and further north, were too far distant for successful transport of bay scallop larvae in sufficient abundance to these traditional beds. This potential explanation implies a continuing impact of the red tide on North Carolina's bay scallop fishery until spawning populations increase in Back Sound and western Bogue Sound. (Author's abstract) W91-01908

**PHYTOPLANKTON BIOMASS AND POTENTIAL NUTRIENT LIMITATION OF PHYTOPLANKTON DEVELOPMENT IN THE SOUTH-EASTERN NORTH SEA IN SPRING 1985 AND 1986.**  
Biologische Anstalt Helgoland (Germany, F.R.)  
For primary bibliographic entry see Field 2L. W91-01937

**PRIMARY PRODUCTION AND NITROGEN ASSIMILATION IN THE NORTH SEA DURING JULY 1987.**  
Plymouth Marine Lab. (England).  
For primary bibliographic entry see Field 2L. W91-01938

**CHANGES IN SPATIAL DISTRIBUTION OF PRIMARY PRODUCTION, PHOTOSYNTHETIC**

**IC PIGMENTS AND PHYTOPLANKTON SPECIES COMPOSITION DURING TWO SURVEYS IN THE GERMAN BIGHT.**  
Rijkswaterstaat, The Hague (Netherlands). Div. of Tidal Waters.  
For primary bibliographic entry see Field 2L. W91-01939

**CHANGES IN SUBLITTORAL ZOOBENTHOS IN THE GERMAN BIGHT WITH REGARD TO EUTROPHICATION.**  
Alfred-Wegener-Inst. fuer Polar- und Meeresforschung, Bremerhaven (Germany, F.R.).  
E. Rachor.  
Netherlands Journal of Sea Research NJSRBA, Vol. 25, No. 1/2, p 209-214, May 1990, 1 fig, 2 tab, 26 ref.

Descriptors: \*Benthic fauna, \*Eutrophication, \*North Sea, \*Population dynamics, \*Water pollution effects, \*Water quality trends, Biomass, Food habits, German Bight, Population density, Species composition.

Comparisons of benthic macrofauna biomass data from early and recent investigations indicate overall increases. These findings are supported by long-term density trends in macrozoobenthos populations from different areas of the German Bight. Examples are given which show that deep-dwelling and long-lived species derive less benefit from changing conditions than animals which (1) live near the sediment surface, (2) have an adaptive feeding behavior, and (3) grow and reproduce quickly. Thus, the observed changes are reflected in the dominance structure of the benthic fauna. These changes are interpreted as being influenced and driven by increased eutrophication. (Author's abstract) W91-01940

**SUCCESSION OF THE PLANKTON COMMUNITY DURING COASTAL RECLAMATION WITH THE SOLID WASTES.**  
Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan).  
For primary bibliographic entry see Field 5E. W91-01943

**CHANGE OF WATER QUALITY AND COMPOSITION OF PLANKTON IN THE POND OF RECLAIMED SITE.**  
Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan).  
For primary bibliographic entry see Field 5E. W91-01944

**EFFECTS OF LOW PH ON THE CHORION OF RAINBOW TROUT, ONCORHYNCHUS MYKISS, AND BROWN TROUT, SALMO TRUTTA F. FARIO.**  
Munich Univ. (Germany, F.R.). Zoologisches Inst. B. Kugel, R. W. Hoffmann, and A. Friess.  
Journal of Fish Biology JFIBA9, Vol. 37, No. 2, p 301-310, August 1990, 4 fig, 36 ref.

Descriptors: \*Acid rain effects, \*Acid streams, \*Acidic water, \*Fish eggs, \*Hydrogen ion concentration, \*Trout, \*Water pollution effects, Embryonic growth stage, Hatching.

The effect of low pH on egg shells (chorion) of rainbow trout, *Oncorhynchus mykiss* Walbaum (formerly *Salmo gairdneri*), and brown trout, *Salmo trutta*, were studied in stream water and dechlorinated tap water. Eggs of rainbow trout and brown trout were exposed to the poorly buffered creek, Hochfallbach in the Bavarian Forest. The average pH during low pH exposure was 5.5, with a minimum pH of 4.9 for several days. Green eggs were exposed for about 2 months and eyed eggs were exposed for about 1 month. In the laboratory, both rainbow and brown trout eggs were incubated as controls in poorly buffered, aerated and dechlorinated tap water at pH 7.3-7.6, or in tap waters artificially acidified with sulfuric acid to a pH 4.0-4.5 or 5.6-6.0. Results of chorion morphological studies showed that the plugs of the outer layer of the chorion, which block the chan-

nels of the underlying layer, developed distinctive vacuolization at low pH exposure in both stream and laboratory tests. This may lead to loss of chorionic semi-permeability. Chorions were incompletely degraded at low pH inducing hatching problems. Partially hatched alevins showed only a small local zone of dissolution of the chorion around the head of the embryo preventing the larvae from being freed for hatching. Results were similar in both rainbow and brown trout eggs. (Geiger-PTT) W91-01959

**COMPARATIVE STUDY ON THE TOXICITY, ABSORPTION AND DEPURATION OF FENITROTHION AND ITS OXON IN JAPANESE TIGER SHRIMP.**  
Kyushu Univ., Fukuoka (Japan). Faculty of Agriculture.  
For primary bibliographic entry see Field 5B. W91-01960

**EFFECT OF SHORT-TERM EXPOSURE TO PENTACHLOROPHENOL A:D OSMOTIC STRESS ON THE FREE AMINO ACID POOL OF THE FRESHWATER AMPHIPOD GAMMARUS PSEUDOLIMNAEUS BOUSFIELD.**  
Michigan State Univ., East Lansing. Pesticide Research Center.  
R. L. Graney, and J. P. Giesy.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 2, p 167-176, March 1987, 1 fig, 4 tab, 34 ref. NOAA Grant NA82RAH00002-ORD-32049.

Descriptors: \*Amino acids, \*Gammarus, \*Osmotic pressure, \*Pentachlorophenol, \*Pesticide toxicity, \*Toxicity, \*Water pollution effects, Amphipods, Biochemical effects, Bioindicators, Phenolic pesticides, Salt stress, Sublethal effects.

The effects of acute stressors on the concentration of free amino acids (FAA) in the freshwater amphipod *Gammarus pseudolimnaeus* were investigated. Forty-eight hours of exposure to acutely toxic concentrations of pentachlorophenol (0.86, 1.16, 1.51, 1.80, and 2.24 mg/L) resulted in a significant decrease in the total FAA pool at the greater concentrations and a significant change in the FAA profile at the lesser concentration. Hyperosmotic conditions did not alter the FAA concentrations while hypoosmotic conditions caused a significant decrease in the total FAA pool. Pentachlorophenol exposure did not impair the ability of amphipods to resist hypoosmotic conditions; however, osmotic stress did influence the organisms ability to recover from toxicant exposure, as measured by changes in the concentration of FAA. The observed alterations in the concentration of total FAA in stressed amphipods is probably related to a disruption in the osmoregulatory ability of the organism. Changes in the FAA pool has potential as an in-situ biochemical indicator of toxicant-induced stress in freshwater invertebrates. (Author's abstract) W91-01967

**ACUTE TOXICITIES AND HEMATOLOGICAL EFFECTS OF TWO SUBSTITUTED NAPHTHOQUINONES IN CHANNEL CATFISH.**  
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.  
A. A. Andaya, and R. T. Di Giulio.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 2, p 233-238, March 1987, 7 tab, 34 ref.

Descriptors: \*Algicides, \*Blood, \*Catfish, \*Fungicides, \*Naphthoquinones, \*Toxicity, \*Toxicology, \*Water pollution effects, Animal tissues, Median tolerance limit, Mortality, Sublethal effects, Tissue analysis.

The acute toxicities and hematological effects of menadione (2-methyl-1,4-naphthoquinone) and dichloro (2,3-dichloro-1,4-naphthoquinone) were examined in yearling channel catfish (*Ictalurus punctatus*). These compounds served as models for quinones, which comprise a diverse group of com-

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pounds that enter aquatic systems from numerous sources. The 96-hour LC50s measured were 720 micrograms/L and 42 micrograms/L for menadione and dieldrin, respectively. In subsequent experiments, fish were exposed for 21 days to concentrations of 0, 0.25, 0.50, and 0.75 times the LC50 value of each compound. For both compounds, generally dose-dependent increases in methemoglobin concentrations and dose-dependent reductions in hemoglobin concentrations and hematocrit ratios were observed. These results are consistent with the hypothesis that these compounds are toxic in part due to their ability to undergo redox cycling and thereby generate reactive oxygen species. However, other modes of action, such as direct enzyme inhibition, may also be important. (Author's abstract)  
W91-01970

#### TOXICITY OF FIVE SHALE OILS TO FISH AND AQUATIC INVERTEBRATES.

National Fisheries Contaminant Research Center, Columbia, MO.  
D. F. Woodward, E. E. Little, and L. M. Smith.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 2, p 239-246, March 1987. 4 tab, 26 ref.

Descriptors: \*Bioassay, \*Fish, \*Invertebrates, \*Oil pollution, \*Oil shale, \*Toxicity, \*Toxicology, \*Water pollution effects, Food chains, Hazard assessment, Median tolerance limit, Minnow, Mortality, Oil characterization, Oil spills, Squawfish, Sublethal effects, Trout.

The chemical composition and toxicity of three shale crude oils (Tosco, Paraho, and Geokinetics), a hydrotreated oil (Paraho HDT), and a refined shale oil (Paraho JP-4) were assessed to determine the potential hazards to native fish species and food chain organisms from accidental spills of such materials. Colorado squawfish (*Ptychocheilus lucius*), fathead minnow (*Pimephales promelas*), cutthroat trout (*Salmo clarki*), and colonies of aquatic invertebrates were exposed to water-soluble fractions of the shale oils for 96 hours to determine concentrations lethal to 50% of the exposed organisms (LC50). The behavior of surviving fish was also measured to determine sublethal influences of exposure. The composition of the five water-soluble fractions was similar to that of the crude and refined shale oils from which they were made. Hydrotreated and refined oils contained fewer aromatic compounds than the crude shale oils. Cutthroat trout, a species endemic to oil shale regions, was less tolerant of shale oil exposure than the other species tested; the LC50 concentrations were 1.8 mg/L for Geokinetics, 2.1 mg/L for Tosco, and 1.3 mg/L for Paraho. Exposure to concentrations of one half to one-eighth those causing mortality reduced the swimming capacity of squawfish and significantly impaired their ability to capture prey. The number of organisms colonizing plate samplers declined with increasing oil concentration. The genera *Baetis* and *Isonychia* were most sensitive to shale oil exposure; significant mortality occurred at the lowest concentration (0.5 to 0.7 mg/L) tested for each shale oil. (Author's abstract)  
W91-01971

#### MUTAGENIC ACTIVITY OF SURFACE WATERS ADJACENT TO A NUCLEAR FUEL PROCESSING FACILITY.

Georgia Univ., Athens. Dept. of Food Science and Technology.  
O. C. Pancorbo, P. J. Lein, and R. D. Blevins.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 16, No. 5, p 531-537, September 1987. 2 tab, 4 fig, 30 ref.

Descriptors: \*Ames test, \*Bioassay, \*Mutagenicity, \*Nuclear fuel, \*Radioactive wastes, \*Toxicology, \*Water pollution effects, Industrial wastes, Mutagens, Path of pollutants, Phosphates, Pollutant identification, Radioisotopes, Spatial distribution, Stream pollution, Wastewater pollution.

Surface waters adjacent to a nuclear fuel processing facility (Nuclear Fuel Services, Inc., Erwin, TN) were extracted, using XAD-resin adsorption

followed by solvent elution, and the extracts were assayed for mutagenic potential by the Ames Salmonella-mammalian microsome test. Dose-related mutagenic responses with TA102 (+S9) were produced with the extracts of water samples obtained from a creek receiving wastewater from the processing facility (specific mutagenic activities of 7,250 to 8250 net revertants per liter equivalent of water). The creek water extracts were not mutagenic with TA102 in the absence of S9, or with any other tester strain, (i.e., TA97, TA98, TA100, and TA1535) in the presence or absence of S9. Surface water samples downstream and upstream of Martin creek were not mutagenic, apparently indicating the lack of persistence of the observed mutagenicity. The major constituent in the mutagenic creek water extracts was identified as tributyl phosphate (TBP) by gas chromatography-mass spectrometry. However, TBP was not mutagenic with TA102 (+S9) at doses ranging from 196 micrograms/plate to 9.8 nanograms/plate. Because tester strain TA102 detects oxidative mutagenesis due to x-rays and ultraviolet radiation, it is possible that the observed mutagenicity of creek water extracts was due to radionuclides complexed to TBP. (Author's abstract)  
W91-01972

#### EFFECT OF HEAVY METALS ON BAY SCALLOPS, SURF CLAMS, AND BLUE MUSSELS IN ACUTE AND LONG-TERM EXPOSURES.

National Marine Fisheries Service, Milford, CT. Milford Lab.  
D. A. Nelson, J. E. Miller, and A. Calabrese.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 17, No. 5, p 595-600, September 1988. 3 fig, 3 tab, 18 ref.

Descriptors: \*Chronic toxicity, \*Clams, \*Heavy metals, \*Mytilus, \*Scallops, \*Toxicity, Bioassay, Copper, Juvenile growth stage, Lead, Median tolerance limit, Mortality, Mussels, Selenium, Water pollution effects, Zinc.

Juvenile Argopecten irradians and Spisula solidissima were exposed to copper (Cu), lead (Pb), selenium (Se) or zinc (Zn) in a 96-hour static bioassay. The order of toxicity for both bivalve species was the same: Cu > Se > Zn > Pb. With the exception of lead, A. irradians were more sensitive than S. solidissima to the metals tested. Juvenile Mytilus edulis were exposed in 96-hour static bioassays to cadmium (Cd), Cu, mercury (Hg), or silver (Ag). The order of toxicity was Cu = Hg = Ag > Cd. M. edulis was as sensitive to Cd as A. irradians. In a 126-day exposure, 45 young-of-the-year A. irradians or S. solidissima, or 45 adult M. edulis were exposed to Cu, using a proportional diluter apparatus. Copper was added to test tanks at concentrations of 0.002, 0.010, or 0.020 mg/L, while control tanks received untreated seawater. Of the three species exposed to the three concentrations of Cu, young-of-the-year S. solidissima were the most sensitive, followed by young-of-the-year A. irradians. Least sensitive was the adult M. edulis. (Author's abstract)  
W91-01973

#### DRILLING FLUIDS AND THE ARCTIC TUNDRA OF ALASKA: ASSESSING CONTAMINATION OF WETLANDS HABITAT AND THE TOXICITY TO AQUATIC INVERTEBRATES AND FISH.

National Fisheries Contaminant Research Center, Jackson, WY. Jackson Field Station.  
For primary bibliographic entry see Field 5B.  
W91-01975

#### RISK ASSESSMENT OF DRINKING WATER IN A RESERVOIR CONTAMINATED BY PAHS ORIGINATED FROM ROAD TRAFFIC.

Ehime Prefecture Inst. of Public Health, Matsuyama (Japan).  
T. Ishimaru, H. Inouye, and T. Morioka.  
The Science of the Total Environment STENDL, Vol. 93, p 125-130, April 1990. 3 fig, 5 tab, 7 ref.

Descriptors: \*Air pollution, \*Carcinogens, \*Drinking water, \*Highway effects, \*Polycyclic aromatic hydrocarbons, \*Reservoirs, \*Risks, \*Water pollution

sources, Aromatic compounds, Assessments, Chemical analysis, Surface runoff, Water analysis.

The loads of polycyclic aromatic hydrocarbons (PAHs) originating from road traffic were measured, and units of per vehicle per meter were estimated as follows: 0.07 ng per vehicle per meter for benzo-a-pyrene, 0.83 ng per vehicle per meter for dibenzanthracene, and 5.77 ng per vehicle per meter for total PAHs. This unit was applied to the risk estimation of drinking water from a reservoir where there are plans to construct a new highway in the near future. Currently, the concentration of PAHs in the reservoir water is estimated to be 3.3 to 101 ng/L for individual PAHs. Assuming standard oral exposure to PAHs in raw water for the drinking water supply, the estimated lifetime risk of carcinogenesis was calculated to be < 1 in 10 million, which is not considered significant. (Author's abstract)  
W91-01991

#### SLURRY-EXPLOSIVE PLANT WASTE WATERS: ENVIRONMENTAL IMPACT AND TREATMENT.

Ravishankar Univ., Raipur (India). Dept. of Chemistry.  
J. K. Moitra, and G. S. Pandey.

The Science of the Total Environment STENDL, Vol. 95, p 191-199, June 1990. 1 fig, 3 tab, 13 ref.

Descriptors: \*Biological wastewater treatment, \*Environmental impact, \*Explosives wastes, \*Groundwater pollution, \*Industrial wastewater, \*Slurries, \*Wastewater treatment, \*Water pollution effects, Acid-charred waste, Ammonium, Effluents, Nitrates, Sludge, Sludge utilization, Wastewater, Water hyacinth, Water quality.

Slurry-explosives are produced by mixing an oxidizing solution of nitrates of ammonium and calcium, thiourea, ethylene glycol, guar gum and water with a solid fuel mix consisting of aluminium powder, starch, tamarind kernel powder, gilsonite and sulfur, in a hydraulically operated mixer, to give a slurry. The major portion of wastewaters is produced during the continuous washing process of the cartridges that hold the slurry. The impact of the discharged wastewater on groundwater quality is noticeable up to a distance of 10 km from the coffer dam. The presence of ammonium and nitrate ions was found up to distance of 5 and 6.5 km, respectively. However, from pH, total dissolved solids and calcium hardness data, the impact of the wastewater can be inferred up to a distance of 10 km. Acid-charred waste from an oxalic acid plant, domestic sewage sludge, and the water hyacinth were used as treatment materials for these wastes. Acid-charred waste was found to be 66 percent effective, and domestic sewage sludge was found to be 95 percent effective in the removal of the nitrogenous content of the wastewaters. The water hyacinth (*Eichhornia crassipes*) removes nitrate and ammonium efficiently when these ions are present below toxicity limits. If cultivated in the vicinity of a slurry-explosive manufacturing plant, the water hyacinth could play a role in the control of contamination of groundwater by nitrogenous compounds in the discharged wastewaters. (Author's abstract)  
W91-02008

#### ECOLOGICAL MECHANISMS IMPORTANT FOR THE BIOTIC CHANGES IN ACIDIFIED LAKES IN SCANDINAVIA.

Goeteborg Univ. (Sweden). Dept. of Zoology.  
J. A. Stenson, and M. O. G. Eriksson.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 201-206, July/August 1989. 78 ref.

Descriptors: \*Acid rain effects, \*Aquatic animals, \*Ecosystems, \*Lake acidification, \*Limnology, \*Path of pollutants, \*Scandinavia, Decomposition, Food chains, Heavy metals, Invertebrates, Predation, Survival, Toxicity, Transparency.

The problem of acidification of freshwaters affected by long distance transported pollutants affects many of the lakes in Scandinavia. Besides direct

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effects, such as reduced reproduction or survival of fish and invertebrates due to low pH or exposure to toxic metals, many indirect effects are also important factors. These indirect effects include ecological mechanisms such as a shift of top predators from fish to invertebrates and a reduced decomposition rate due to decreased abundance of detritivores; as well as feedback effects on the abiotic environment, such as reduced productivity and turnover rate of nutrients and an increase in water transparency. Impaired reproduction among passerine birds has been related to exposure of aluminum through the intake of insects emerging from acidified waters. Adverse effects on duck populations due to reduced abundance or quality of food organisms has been emphasized more in North America than in Scandinavia, but combined effects of acidity and predation pressure from acid-tolerant fish contribute to low abundances of waterfowl. (Brunone-PTT)  
W91-02015

#### ACUTE TOXICITY OF SELECTED HERBICIDES AND SURFACTANTS TO LARVAE OF THE MIDGE CHIRONOMUS RIPARIUS.

National Fisheries Contaminant Research Center, Yankton, SD. Field Research Station.  
K. J. Buhl, and N. L. Faerber.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 530-536, July/August 1989. 4 tab, 24 ref.

Descriptors: \*Aquatic insects, \*Bioassay, \*Herbicides, \*Midges, \*Surfactants, \*Toxicity, \*Water pollution effects, Alachlor, Bromoxynil, Butylate, Insect larvae, Lethal limit, Metribuzin, Storms, Triallate.

The acute toxicities of eight commercial herbicides and two surfactants to early fourth instar larvae of the midge *Chironomus riparius* were determined under static conditions. The formulated herbicides tested were Eradicane (EPTC), Fargo (triallate), Lasso (alachlor), ME4 Brominal (bromoxynil), Ramrod (propachlor), Rodeo (glyphosate), Sencor (metribuzin), and Sutan (+) (butylate); the two surfactants were Activator N.F. and Ortho X-77. In addition, technical grade alachlor, metribuzin, propachlor, and triallate were tested for comparison with the formulated herbicides. The relative toxicity of the commercial formulations, based on percent active ingredient, varied considerably. The EC50 values ranged from 1.23 mg/L for Fargo to 5600 mg/L for Rodeo. Fargo, ME4 Brominal, and Ramrod were moderately toxic to midge larvae; Lasso, Sutan (+), and Eradicane were slightly toxic; and Sencor and Rodeo were practically non-toxic. The 48-hour EC50 values of the two surfactants were nearly identical and were considered moderately toxic to midges. For two of the herbicides, in which the technical grade material was tested, the inert ingredients in the formulations had a significant effect on the toxicity of the active ingredients. Fargo was twice as toxic as technical grade triallate, whereas Sencor was considerably less toxic than technical grade metribuzin. A comparison of the slope function values indicated that the toxic action of all compounds occurred within a relatively narrow range. In general, the relative order of toxicity to *Chironomus riparius* was similar to those for other freshwater invertebrates. Maximum concentrations of each herbicide in bulk runoff during a projected critical runoff event were calculated as a percentage of the application rate lost in a given volume of runoff. A comparison between estimated maximum herbicide concentrations in runoff and results of acute tests indicated that Ramrod, ME4 Brominal, and Lasso pose the greatest direct risk to midge larva during a storm event. (Author's abstract)  
W91-02017

#### MACROINVERTEBRATE AND PERIPHYTON RESPONSE TO STREAMBED AGITATION FOR RELEASE OF SUBSTRATE-TRAPPED HYDROCARBONS.

Idaho Univ., Moscow. Dept. of Plant, Soil and Entomological Sciences.  
K. W. Pontasch, and M. A. Brusven.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 545-553,

July/August 1989. 6 fig, 1 tab, 29 ref.

Descriptors: \*Aquatic plants, \*Cleanup operations, \*Hydrocarbons, \*Idaho, \*Macroinvertebrates, \*Oil spills, \*Periphyton, Chlorophyll a, Mixing, Sediment chemistry, Species diversity.

Following a spill of more than 94.4 cubic m of unleaded gasoline into Wolf Lodge Creek in northern Idaho, impacted areas were mechanically agitated to release substrate-trapped hydrocarbons by dragging a bulldozer blade with a tightly wound chainlink fence attached to it backward over the substrate. Portions of two riffles were left unagitated to determine if differential recovery of benthic macroinvertebrates and periphyton in cleaned versus uncleaned areas of the stream would occur. Chlorophyll a concentrations and densities of most macroinvertebrates were significantly lower ( $P < 0.05$ ) in raked areas 12 days after stream cleaning. However, macroinvertebrate and periphyton community compositions were very similar 1 month after stream cleaning and for the remainder of the study. In spite of similar recovery times of macroinvertebrates and periphyton in raked and nonraked areas, the cleaning process is viewed as beneficial because it minimized possible chronic effects on the biota without causing substantial additional impact. (Author's abstract)  
W91-02019

#### EFFECTS OF CADMIUM ON MUREX TRUNCULUS FROM THE ADRIATIC SEA: I. ACCUMULATION OF METAL AND BINDING TO A METALLOTHIONEIN-LIKE PROTEIN.

Innsbruck Univ. (Austria). Inst. fuer Zoologie.  
For primary bibliographic entry see Field 5B.  
W91-02020

#### EFFECTS OF CADMIUM ON MUREX TRUNCULUS FROM THE ADRIATIC SEA: II. OXYGEN CONSUMPTION AND ACCLIMATION EFFECTS.

Innsbruck Univ. (Austria). Inst. fuer Zoologie.  
G. J. Dalla Via, R. Dallinger, and E. Carpena.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 562-567, July/August 1989. 4 fig, 1 tab, 21 ref.

Descriptors: \*Adriatic Sea, \*Bioaccumulation, \*Bioassay, \*Cadmium, \*Heavy metals, \*Mollusks, \*Oxygen requirements, \*Toxicity, \*Toxicology, \*Water pollution effects, Acclimatization, Biomass, Snails.

Marine snails (*Murex trunculus*) from the Adriatic Sea were exposed to cadmium in the laboratory under chronic (0.05 mg/L) and acute (5 mg/L) conditions. More than 5 mg/L cadmium were required to lethally damage *Murex trunculus* during an exposure of 96 hours. Compared with untreated animals, chronic exposure of *Murex trunculus* to 0.05 mg/L cadmium results in an elevated rate of oxygen consumption. The difference between the two groups of snails increases with time. After one month, a 10% greater loss in biomass in treated animals than in controls was observed, reflecting the higher energy expenditure during exposure to 0.05 mg/L cadmium. An acute cadmium shock of 5 mg/L caused depression of oxygen consumption both in the control and in long term pre-exposed snails to 0.05 mg/L. If pre-exposure to a low concentration of cadmium lasted for a short time only (18 hours) a subsequent acute cadmium shock did not lead to a depression of the rate of oxygen consumption. (See also W91-02020) (Author's abstract)  
W91-02021

#### EFFECT OF WATERBORNE AND DIETARY CADMIUM ON PLASMA IONS OF THE TELEOST OREOCHROMIS MOSSAMBICUS IN RELATION TO WATER CALCIUM LEVELS.

Dar es Salaam Univ. (Tanzania). Dept. of Zoology and Marine Biology.  
H. B. Pratap, H. Fu, R. A. C. Lock, and S. E. W. Bonga.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 568-575, July/August 1989. 2 tab, 59 ref.

Descriptors: \*Cadmium, \*Calcium, \*Fish physiology, \*Heavy metals, \*Toxicity, \*Toxicology, \*Water chemistry, \*Water pollution effects, Bioaccumulation, Cichlid, Metabolism, Tilapia.

The effects of cadmium administered via ambient water or food on plasma ions of the African freshwater cichlid *Oreochromis mossambicus* were studied for 2, 4, 14 and 35 days, in low calcium (0.2 mM) and high calcium (0.8 mM) water. In low calcium water, an environmentally relevant concentration of 10 microg/L water-borne cadmium induced a significant and dramatic hypocalcemia on days 2 and 4. Recovery of plasma calcium was observed on days 14 and 35. Hypermagnesemia was observed on day 2, but normal levels were already found on day 4. In high calcium water adapted fish, the extent of hypocalcemia and hypermagnesemia was less pronounced than in fish from low calcium water. Water-borne cadmium caused no significant changes in plasma phosphate, sodium, potassium or osmolality. On days 2 and 4, dietary cadmium (averaging 10 microg cadmium/fish/day) caused hypermagnesemia and hypocalcemia in low calcium water adapted fish. Recovery was observed on days 4 and 14, respectively. In fish from high calcium water, dietary cadmium caused a significant reduction in plasma calcium on day 4 only; plasma magnesium was unaffected. Hyperphosphatemia was apparent on day 14, irrespective of the water calcium concentration. No changes in plasma sodium, potassium, or osmolality were found. The results show that sublethal concentrations of cadmium, administered via the water as well as via the food, affect calcium and magnesium metabolism in tilapia. High water calcium ameliorates the effects of both water and dietary cadmium on plasma calcium and magnesium levels. (Author's abstract)  
W91-02022

#### UPTAKE AND ELIMINATION OF WATERBORNE CADMIUM BY THE FISH NOEMACHEILUS BARBATULUS L. (STONE LOACH). Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station. P. E. T. Douben.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 576-586, July/August 1989. 4 fig, 7 tab, 49 ref.

Descriptors: \*Bioaccumulation, \*Bioassay, \*Cadmium, \*Fish physiology, \*Heavy metals, \*Metabolism, \*Toxicity, \*Water pollution effects, Feeding, Growth rates, Stone loach, Temperature effects.

Fish, *Nemacheilus barbatulus* L. (stone loach), were exposed to cadmium in water to study rates of uptake and loss in three experiments: one during which they were exposed for up to 4 days to 1.0 mg/L cadmium and subsequently kept in clean water for up to another 8 days at 8°C, 16°C, and 18°C; a second one during which fish were exposed to a range of cadmium concentrations in water (0.08 to 0.93 mg/L); and a third one during which they were starved or fed with Tubifex while some were exposed to 0.067 mg/L cadmium. All levels were well below those that are acutely toxic. Results showed that fed fish did not change weight while all starved fish lost weight, at a higher rate for exposed fish than for control fish. Size of the fish affected rates of uptake and loss of cadmium. These rates increased with temperature. Bioconcentration factors decreased with size of fish, increased with temperature up to about 16°C and decreased as the concentration of cadmium in water increased. Feeding appears to increase the rate of intake of cadmium from the water. Metabolic rate governed rates of uptake and loss. (Author's abstract)  
W91-02023

#### EFFECTS OF DIET, WATER HARDNESS, AND POPULATION SOURCE ON ACUTE AND CHRONIC COPPER TOXICITY TO CERIODAPHNIA DUBIA.

S. E. Belanger, J. L. Farris, and D. S. Cherry.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 18, No. 4, p 601-611, July/August 1989. 2 fig, 5 tab, 28 ref.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

Descriptors: \*Bioassay, \*Copper, \*Diets, \*Heavy metals, \*Toxicity, \*Toxicology, \*Water pollution effects, \*Waterflea, Hardness.

The effects of diet, water hardness, and population source on acute toxicity, and diet and water hardness on chronic toxicity of copper to *Ceriodaphnia dubia* were investigated. A diet of three algae (*Chlamydomonas reinhardtii*, *Ankistrodesmus falcatus*, and *Chlorella vulgaris*, hereafter referred to as CAC) cultured in vitamin-enriched media was superior to synthetic diets consisting of yeast, Cerophyll, and trout chow (YCT). Neonates from mothers reared on CAC were 1.4 to 1.5 times more resistant to copper than those reared on YCT or yeast and Cerophyll. Forty-eight hour LC50s of copper to *C. dubia* increased from 35 to 79 microg/L at water hardness of 94 and 170 mg/L calcium carbonate/L. Three populations of *Ceriodaphnia* derived from three US Environmental Protection Agency laboratories showed no differential copper sensitivity. Chronic copper impairment was measured by neonate production in the 7-day life cycle test. Chronic values were 7.9 and 10.1 microg/L at water hardnesses of 94 and 170 mg/L respectively. A comparison of daily water renewal and renewal on days 3 and 5 only was made, showing that neonate production was significantly greater using day 3 and 5 renewals (Friedmann's Rank Sum Test,  $p < 0.005$ ), even though copper concentrations were comparable between the two tests. Therefore, handling stress may have occurred using daily changes. It is recommended that future tests and US EPA guidelines should address deleting YCT and including multi-algal diets for culturing and chronic testing of *Ceriodaphnia*. (Author's abstract) W91-02024

#### PHYSIOLOGICAL RESPONSES TO SEVERE ACID STRESS IN FOUR SPECIES OF FRESH-WATER CLAMS (UNIONIDAE).

Helsinki Univ. (Finland). Dept. of Zoology. K. Pynnonen.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 471-478, July/August 1990. 5 fig, 6 tab, 28 ref.

Descriptors: \*Acid rain effects, \*Acidic water, \*Bioassay, \*Mollusks, \*Water pollution effects, Calcium, Chlorides, Clams, Finland, Hardness, Hydrogen ion concentration, Physiology, Potassium, Sodium.

Four species of freshwater clam, *Anodonta anatina*, *A. cygnea*, *Unio pictorum*, and *U. tumidus* were exposed for 2 weeks to acidified soft water (pH 4.0 to 4.5, calcium 4.6 mg/L) and for 4 weeks to acid in hard water conditions (calcium 18.5 mg/L). The exposures caused a decrease in sodium ions, potassium ions and chloride ions and a rapid increase of calcium ions in the hemolymph. The elevation of the hemolymph calcium ions was positively correlated with the decrease in the hemolymph pH in all species studied. Low ambient calcium ion level accelerated the pH decrease and calcium ion increase in the hemolymph. Sodium and chloride ion concentrations changed less rapidly in the soft conditions. Although there were minor changes in the mineral composition of the calcium concretions in the gills, the amount of calcium in the concretions did not change during the exposure. There was no correlation between the thickness of the shell and the ionic response, but all four species responded to low ambient pH in the same way. (Author's abstract) W91-02026

#### MORPHOMETRIC AND X-RAY ENERGY DISPERSIVE APPROACH TO MONITORING PHALTERED CADMIUM TOXICITY IN ANABAENA FLOS-AQUAE.

Herbert H. Lehman Coll., Bronx, NY. Dept. of Biological Sciences.

L. C. Rai, T. E. Jensen, and J. W. Rachlin. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 479-487, July/August 1990. 6 fig, 7 tab, 36 ref. Minority Biomedical Research Grant No. 4-42433, Faculty Research Award Program Grant 6-67202.

Descriptors: \*Acid rain effects, \*Algae, \*Cadmium, \*Cyanophyta, \*Heavy metals, \*Hydrogen ion concentration, \*Morphology, \*Toxicity, \*Trace elements, \*Water pollution effects, Absorption, Bioassay, Monitoring.

Cyanobacteria are a group of procaryotic photosynthetic microbes with a genome plasticity that allows them to grow in some of the harshest environments. To date, there is no information on the combined effects of pH and cadmium toxicity on ultrastructural changes in algae; nor have the ultrastructural effects of pH alone been documented. Cadmium toxicity and uptake as influenced by different pH values were investigated in the freshwater cyanophyte *Anabaena flos-aquae*, using morphometric analysis, x-ray energy dispersive analysis and atomic absorption spectrophotometry. A general reduction in cell dimension, thylakoid surface area, number and volume of polyhedral bodies, polyphosphate bodies, cyanophycin granules, lipid bodies, membrane limited crystalline inclusions, volume and number of wall layers and mesosomes was observed. These reductions were more pronounced in both acidic and alkaline medium than at pH 7.2. At 0.12 microM cadmium, the uptake increased with alkaline pH values, and uptake was greater at pH 7.2 than at either acid or alkaline pHs. Lysis of cell wall at 1.18 microM cadmium showed the following decreasing trend: pH 4.0 > pH 5.5 > pH 10 > pH 9.0 > pH 7.2. A total loss of lipid bodies at 1.18 microM cadmium resulted at all pH values listed. These techniques could be successfully employed for bioassay studies of metal toxicity to algae. In particular, cell wall lysis and loss of lipids by algae are good indicators of pH effects and metal toxicity in the aquatic ecosystem. (Author's abstract) W91-02027

#### TOXICITY AND BIOACCUMULATION OF SELENATE, SELENITE AND SELENO-L-METHIONINE IN THE CYANOBACTERIUM ANABAENA FLOS-AQUAE.

California Univ., Davis. Dept. of Land, Air and Water Resources.

P. Kiffney, and A. Knight. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 488-494, July/August 1990. 1 fig, 6 tab, 29 ref. DOI-USGS Project No. 140800001G and Univ. of California Salinity/Drainage Task Force Project No. 86-9.

Descriptors: \*Bioaccumulation, \*Cyanophyta, \*Heavy metals, \*Selenium, \*Toxicity, \*Water pollution effects, Amino acids, Bacterial physiology, Chlorophyll a, Food chains, Metabolism.

A laboratory investigation was conducted to study the toxicity and bioaccumulation of seleno-L-methionine, selenate and selenite in the cyanobacterium *Anabaena flos-aquae*. The first sublethal effects of seleno-L-methionine, selenite and selenate occurred at 0.1, 3.0 and 3.0 mg/L, respectively with a decrease in chlorophyll a concentration ( $P < 0.0001$ ). Selenium bioconcentration factors were in the order of seleno-L-methionine, selenite, and selenate. Significant decreases in intracellular selenium concentration were observed at both the no effect and low level effect at each oxidation state tested in the given experiment ( $P < 0.0001$ ). The preferential uptake of selenite and seleno-L-methionine was explained by the additional energy consuming metabolic steps necessary for the algae to reduce and incorporate selenate into sulfur amino acids. The mechanism by which algae regulate selenium to ameliorate toxicity is still not known. The poisoning of the upper trophic levels in selenium contaminated systems is due to the bioconcentration of selenium by primary producers and the subsequent biomagnification of the toxic organic forms of selenium up the aquatic food chain. Therefore, this cyanobacterium is a potentially dangerous food source in the aquatic food chain in selenium contaminated systems. (Brunone-PTT) W91-02028

#### BIOACCUMULATION OF SELENIUM IN BIRDS AT KESTERTON RESERVOIR, CALIFORNIA.

Patuxent Wildlife Research Center, Davis, CA.

Pacific Coast Field Station.

H. M. Ohlendorf, R. L. Hothem, C. M. Bunck, and K. C. Marois.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 495-507, July/August 1990. 3 fig, 8 tab, 45 ref, append.

Descriptors: \*Bioaccumulation, \*Birds, \*California, \*Kesterson Reservoir, \*Selenium, \*Toxicity, \*Water pollution effects, Depuration, Food chains, Heavy metals, Physiology, Tissues.

Selenium concentrations in tissues of birds collected during the 1984 to 1985 nesting seasons at Kesterson Reservoir (an area receiving high selenium irrigation drainage water) were determined. These concentrations were compared with those from birds from reference sites within California's Central Valley, and relate to foodchain selenium concentrations at the study sites. Within years, selenium in livers of adult birds collected early and late in the nesting season changed significantly at both Kesterson and the primary reference site (Volta Wildlife Area). These changes were related to the length of time birds had been present at the study sites and the associated accumulation (at Kesterson) or depuration (at Volta) of selenium. All species showed significant location differences, which were greatest in species that occurred at Kesterson throughout the year or fed more consistently within the reservoir. There were few species differences in selenium for birds at the reference sites (where food chain selenium levels were normal ( $< 2$  microg/g dry weight)). At Kesterson (where bird foods generally contained  $> 50$  microg selenium/g), species patterns varied by year, probably because of varying periods of residence and other factors. Selenium concentrations in kidneys and livers of American coots (*Fulica americana*) were significantly correlated ( $r = 0.9845$ ); selenium concentrations in breast muscles and livers of juvenile ducks (*Anas* spp.) also were correlated ( $r = 0.8280$ ). Body weights of adult coots were negatively correlated with liver selenium concentration. Late-season resident breeding birds or pre-fledged juvenile birds reared at a site usually provided the best indication of site-specific selenium bioaccumulation. (Author's abstract) W91-02029

#### EXPRESSION OF RESULTS FROM GROWTH INHIBITION TOXICITY TESTS WITH ALGAE.

Vandkvalitetsinstituttet, Hoersholm (Denmark).

N. Nyholm.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 518-522, July/August 1990. 4 fig, 2 tab, 14 ref.

Descriptors: \*Algal growth, \*Bioassay, \*Bioindicators, \*Growth rates, \*Toxicity, \*Toxicology, Biomass, Dose-response relationships, Plant physiology.

Results from six growth inhibition toxicity tests with the freshwater green algae *Selenastrum capricornutum* and *Scenedesmus subspicatus* have been analyzed using both biomass measurements and estimates of the specific growth rate to quantify the toxic response. For exponentially growing cultures, biomass derived effective concentrations (EC's) decrease with time, but reach asymptotic values in the course of some days. The final (asymptotic) values are smaller than EC figures derived from growth rates, and the differences are greater, the smaller the slope of the dose response curve. EC50 values differed by up to a factor of 5. Standard test protocols for routine testing should prescribe the use of some appropriate measure of the specific growth rate, rather than the biomass, as the response variable. (Author's abstract) W91-02031

#### EFFECTS OF PARAQUAT ON MORTALITY AND CARDIORESPIRATORY FUNCTION OF CATFISH FRY PLECOSTOMUS COMMERSONI.

Universidad Nacional de Lujan (Argentina). Lab. of Ecotoxicology.

M. C. Tortorelli, D. A. Hernandez, G. Rey Vazquez, and S. Salibian.

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Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p. 523-529, July/August 1990. 4 fig, 5 tab, 19 ref. CONICET (Resol. 0318-9780/86 and CIC-Bs.As (Resol. 7500-7587/86).

Descriptors: \*Catfish, \*Fish physiology, \*Herbicides, \*Paraquat, \*Toxicity, \*Toxicology, \*Water pollution effects, Gills, Microscopy, Morphology, Mortality.

The effects of a paraquat commercial herbicide formulation on an early stage of the development of *Plecotomus commersoni* were evaluated. Mortality, opercular ventilation rate, cardiac contraction rate and body length were examined every twelve hours. The effects of the paraquat formulation on the morphology of the branchial epithelium were also examined by light microscopy. The assayed paraquat formulation significantly affected cardiac contraction and opercular ventilation. Ecotoxicologically, this could represent an important deleterious effect for early development of the catfish. Mortality data may not be sufficient for an appropriate evaluation of secondary environmental hazards associated with the application of paraquat formulation because the LC-50 values for *Plecotomus commersoni* fry were higher than the recommended individual application rate of paraquat for aquatic weed control (0.1 to 2.0 mg/L), and the estimated maximum acceptable toxicant concentration (MATC) resulted in a concentration similar to the application rate when calculated from acute toxicity. When the MATC was estimated from opercular ventilation or cardiac contraction rates, it was lower and fell within the recommended single application rates. (Author's abstract) W91-02032

#### GEOGRAPHIC VARIATION OF CHLORINATED HYDROCARBONS IN BURBOT (LOTA LOTA) FROM REMOTE LAKES AND RIVERS IN CANADA.

Department of Fisheries and Oceans, Winnipeg (Manitoba). Central and Arctic Region. For primary bibliographic entry see Field 5B. W91-02033

#### CHRONIC TOXICITY AND BIOACCUMULATION OF 2,5,2',5'- AND 3, 4, 3',4'-TETRACHLOROBIPHENYL AND AROCLOR 1242 IN THE AMPHIPOD HYALELLA AZTECA.

Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences. U. Borgmann, W. P. Norwood, and K. M. Ralph. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p. 558-564, July/August 1990. 4 fig, 3 tab, 25 ref.

Descriptors: \*Amphipods, \*Aroclors, \*Bioaccumulation, \*Tetrachlorobiphenyl, \*Toxicity, \*Toxicology, Aquatic fauna, Biomagnification, Food chains, Invertebrates, Mortality, Polychlorinated biphenyls.

The addition of 100 microg/L of Aroclor 1242 or 2,5,2',5'-tetrachlorobiphenyl (TeCB) during 10 week chronic toxicity tests with *Hyalella azteca* resulted in complete mortality. There were no effects on survival, growth or reproduction after addition of 30 microg/L. Toxic effects were observed at tissue levels of between 30 and 180 microg/g on a wet weight basis, and tissue levels appear to be a better indicator of toxicity than levels in water. No toxic effects were observed after addition of up to 2700 microg/L of the coplanar congener 3,4,3',4'-TeCB. *H. azteca* has the ability to avoid accumulating in excess of 140 microg/g 3,4,3',4'-TeCB. The amount taken up was proportional to the amount added in water up to 100 microg/L, but was constant at higher additions, possibly accounting for its relatively low toxicity. The low toxicity of the coplanar congener, as compared to the non-coplanar 2,5,2',5'-TeCB, is in direct contrast to the high toxicity of coplanar PCB congeners to mammals and may be associated with slower rates of aromatic hydrocarbon metabolism in amphipods. Polychlorinated biphenyl levels measured in amphipods from Lake Ontario are approximately 100-fold below levels

associated with toxicity in *H. azteca*, but are above levels which, through biomagnification up the food chain, lead to salmonid residues in excess of 2 microg/g, a tolerance limit for human consumption. (Author's abstract) W91-02035

#### COMPARATIVE TOXICOKINETICS OF 2,2'-DICHLOROBIPHENYLS AND 4,4'-DICHLOROBIPHENYLS IN THE POND SNAIL LYMNAEA STAGNALIS.

Vrije Univ., Amsterdam (Netherlands). Dept. of Pharmacochimistry. M. Wilbrink, M. Treskes, T. A. De Vlieger, and N. P. E. Vermeulen. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p. 565-571, July/August 1990. 4 fig, 2 tab, 30 ref.

Descriptors: \*Dichlorobiphenyls, \*Mollusks, \*Path of pollutants, \*Polychlorinated biphenyls, \*Snails, \*Toxicity, \*Toxicology, \*Water pollution effects, Temporal distribution.

Pond snails (*Limnaea stagnalis* (L.)) were treated with 2,2'-dichlorobiphenyl (DCB) or 4,4'-DCB, to examine the toxicokinetic profile of these compounds. Snails were treated orally with 210 microg 4,4'-DCB (impregnated on food) for 14 hours, or snails were injected with 50 microg of 2,2'-DCB or 4,4'-DCB in the foot. At different times after starting feeding or injection, tissues (albumen gland, digestive gland and digestive tube, central nervous system, remainder parts), hemolymph and feces were analyzed for unchanged 2,2'-DCB or 4,4'-DCB. The results showed that in the case of oral administration of 4,4'-DCB after 144 hr, 97.5% of the dose was excreted unchanged in the feces. During the first 48 hours, 4,4'-DCB was found in all tissues. Thereafter, an exponential elimination was found (The rate constant of elimination varied from 0.010 to 0.021 per hour, half life from 33 to 60 hours and the apparent clearance from 0.02 to 0.3 g/hr for the different tissues). After injection, the compounds were found in all the above mentioned tissues, especially in the digestive gland. There was a clear difference between snails injected with 2,2'-DCB and 4,4'-DCB. Firstly, the rate constant of elimination 2,2'-DCB was higher (0.028 per hr vs 4,4'-DCB: 0.001 per hr). Secondly, 2,2'-DCB was lethal; 63% of the animals died after 72 hours. (Author's abstract) W91-02036

#### TOXICOLOGICAL EXAMINATION OF WHITEFISH (COREGONUS CLUPEAIFORMIS) AND NORTHERN PIKE (ESOX LUCIUS) EXPOSED TO URANIUM MINE TAILINGS.

Environmental Protection Service, Regina (Saskatchewan). D. T. Waite, S. R. Joshi, H. Sommerstad, G. Wobeser, and A. A. Gajadhar. Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p. 578-582, July/August 1990. 1 fig, 3 tab, 10 ref.

Descriptors: \*Bioaccumulation, \*Canada, \*Pike, \*Radioactive wastes, \*Toxicity, \*Toxicology, \*Uranium, \*Water pollution effects, \*Whitefish, Enzyme activity, Fecundity, Fish parasites, Histopathology, Lake Athabasca, Langley Bay, Mine tailings, Sediment chemistry.

Operation of the Gunnar uranium mine, in northern Saskatchewan, Canada, from 1955 to 1964, resulted in the deposition of radioactive tailings in Langley Bay, a small bay connected to Lake Athabasca. The sediments, water, macrophytes and fish of this area have been contaminated with uranium mine tailings. The parasite infestation, blood hematocrit, histopathology and condition factor of the Langley Bay whitefish and northern pike populations were compared with those from Lake Athabasca. Parasite infestations of the control area were very similar to those of Langley Bay. Differences in parasite fauna probably reflect habitat differences rather than debilitation from exposure to radionuclides. The highest concentrations of radionuclides were found in the gut contents and bone of whitefish from Langley Bay. Kidney tissue contained higher radionuclide concentrations than

other soft tissues. The concentrations of radionuclides and other heavy metals in the tissues and environment of Langley Bay whitefish had not caused overt histopathological changes in these fish. No significant differences could be found, in any of the physiological parameters measured, between the contaminated and control populations. Many other aspects of the health of these fish populations have not been studied including: genetic make-up; fecundity; blood plasma chemistry; and, enzyme function. The lack of information in the literature on the uptake rates and mechanisms for natural radionuclides has hampered toxicological studies of these populations. (Brunone-PTT) W91-02037

#### SUBLETHAL AND ACUTE TOXICITY OF THE ETHYLENE GLYCOL BUTYL ETHER ESTER FORMULATION OF TRICLOPYR TO JUVENILE COHO SALMON (ONCORHYNCHUS KISUTCH).

Simon Fraser Univ., Burnaby (British Columbia). Dept. of Biological Sciences. J. A. Johansen, and G. H. Geen.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p. 610-616, July/August 1990. 3 fig, 4 tab, 20 ref.

Descriptors: \*Fish physiology, \*Herbicides, \*Salmon, \*Toxicity, \*Triclopyr, \*Water pollution effects, Dose-response relationships, Fish behavior, Fishkill, Oxygen requirements, Uptake.

The toxicity of Garlon 4, the ethylene glycol butyl ether ester formulation of the herbicide triclopyr, to juvenile coho salmon (*Oncorhynchus kisutch*) was investigated at several lethal and sublethal concentrations. Fish behavior, random activity, and oxygen uptake were monitored. Coho salmon exhibited three distinct responses related to concentration and duration of exposure: (1) at concentrations greater than 0.56 mg/L fish were initially lethargic, then regressed to a highly distressed condition characterized by elevated oxygen uptake and finally death, (2) at 0.32 to 0.43 mg/L fish were lethargic throughout the exposure period with reduced oxygen uptake, and (3) at concentrations  $\leq 0.10$  mg/L fish were hypersensitive to stimuli, exhibiting elevated activity and oxygen uptake levels during photoperiod transitions. Whole body residue analysis showed that uptake of the ester and subsequent hydrolysis to the acid form in the fish was rapid, with significant accumulation of the acid in the tissues. This result suggests that some threshold tissue concentrations were associated with the observed results. For juvenile coho salmon the 96 hour LC40 of Garlon 4 was 0.84 mg/L. (Author's abstract) W91-02039

#### EFFECTS OF SHORT-TERM PULSES OF ATRAZINE ON ATTACHED ALGAL COMMUNITIES IN A SMALL STREAM.

Texas Christian Univ., Fort Worth. Dept. of Biology. T. A. Jurgensen, and K. D. Hoagland.

Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p. 617-623, July/August 1990. 4 fig, 6 tab, 46 ref.

Descriptors: \*Algae, \*Atrazine, \*Ecosystems, \*Herbicides, \*Stream biota, \*Toxicology, \*Water pollution effects, Algal toxicity, Biomass, Nebraska, Plant physiology, Sedimentation.

The impact of short-term atrazine exposures on attached algal community composition and standing crop was investigated during the summer in a small, spring-fed stream in western Nebraska. Replicate trays of clay tiles were anchored to the stream bed, allowed to colonize for two weeks, then enclosed in situ with plexiglass boxes and exposed to a pulse of atrazine at 0, 2, 30, or 100 microg/L for 24 hours. A second 24-hour atrazine pulse was applied two weeks later. Atrazine did not have a significant effect on cell densities of the dominant algae or the ash-free dry weight biomass of the periphyton community. The absence of observed treatment effects was likely due to the low but realistic levels of atrazine used and the tran-

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects Of Pollution

sient nature of the application. Sediment deposition had a much greater influence on the attached algal community than short term pulses of the herbicide. (Author's abstract)  
W91-02040

**COMPARATIVE TOXICITIES OF SELECTED INDUSTRIAL CHEMICALS TO MICROORGANISMS AND OTHER AQUATIC ORGANISMS.** Wisconsin Univ.-Superior. Center for Lake Superior or Environmental Studies.  
D. D. Vaishnav, and E. T. Korthals.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 4, p 624-628, July/August 1990. 2 fig, 2 tab, 23 ref. EPA Cooperative Agreement No. CR809234.

**Descriptors:** \*Aquatic life, \*Copepods, \*Fish, \*Microorganisms, \*Toxicity, \*Toxicology, \*Water pollution effects, \*Waterflea, \*Alcohols, \*Barnacles, \*Bioassay, \*Biodegradation, \*Growth rates, \*Ketones, \*Naphthalenes, \*Phenols, \*Statistical analysis.

Microorganisms are particularly suitable for use in rapidly screening chemical toxicity because they are relatively easy to handle, have rapid growth rates, provide reproducible results, and are inexpensive to grow and maintain. Biodegradation rates of 25 narcotic industrial chemicals were determined nonmetabolically using resting cells prepared from preacclimated mixed cultures of microorganisms. These chemicals included straight-chain and cyclic alcohols and ketones as well as naphthalene and phenol. Chemical concentrations that would reduce maximum rates by 50% (BIC50) were estimated from rate inhibition data. Subsequently, the BIC50 and acute toxicities of chemicals to daphnids, barnacle larvae, copepods, and fish (bleak, fathead minnow and golden orfe) were correlated. The r-squared and F-statistics for all six linear correlations were significant ( $\alpha = 0.001$ ). This result suggests, for chemicals having a non-specific mode of toxic action, the biodegradation inhibition test may be used to estimate concentrations which would be toxic to higher aquatic organisms. A comparison of toxicity data showed microorganisms were less sensitive to test chemicals than the other species. Chemical concentrations causing 50% inhibition of the maximum rates of microbial degradation to the six aquatic organisms correlated well for selected narcotic industrial chemicals. The test may also be adapted for evaluating colored or turbid samples, and the bioavailable chemicals in sediment or soil. (Brunone-PTT)  
W91-02041

**PARTITIONING OF LINDANE BETWEEN SEDIMENT, WATER AND THE CRUSTACEAN METAPENAEUS MACLEAYI.** Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.  
For primary bibliographic entry see Field 5B.  
W91-02042

### 5D. Waste Treatment Processes

**INFLUENCE OF WATER CHEMISTRY ON SUSPENDED SOLIDS IN COAL MINE SEDIMENTATION PONDS.** Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.  
V. P. Evangelou.  
Journal of Environmental Quality JEVAQ, Vol. 19, No. 3, p 428-434, July/September 1990. 3 fig, 5 tab, 25 ref.

**Descriptors:** \*Coal spoil, \*Kentucky, \*Salinity, \*Sedimentation basins, \*Suspended solids, \*Waste disposal, \*Waste treatment, \*Water quality, \*Coal mine effects, \*Conductivity, \*Dispersion, \*Flocculation, \*Repulsion, \*Sediment control.

In Kentucky, water quality in coal mine sedimentation ponds is lowered by high concentrations of suspended solids. Soil samples from surface mine sites in eastern and western Kentucky were equilibrated with distilled water to evaluate their effects on suspended solids. The results demonstrate that

small changes in salt concentration have large effects on suspended solid concentration. Furthermore, it was determined that for the ranges of water chemistry encountered in such environments, there is a linear relationship between the repulsive index (RI) and suspended solids. Increasing the electrical conductivity reduces RI and increases the rate of settling. The trapping efficiency of sedimentation ponds during base flow is highly dependent on the physicochemical forces dictating dispersion/flocculation processes. (Author's abstract)  
W91-01013

**INFLUENCE OF IMMOBILIZATION SUPPORTS ON KINETIC CONSTANTS OF ANAEROBIC PURIFICATION OF OLIVE MILL WASTEWATER.**

Instituto de la Grasa y sus Derivados, Seville (Spain).  
J. A. Fiestas, A. Martin, and R. Borja.  
Biological Wastes BIWAED, Vol. 33, No. 2, p 131-142, 1 fig, 12 tab, 4 ref, 1990.

**Descriptors:** \*Anaerobic digestion, \*Industrial wastewater, \*Kinetics, \*Wastewater treatment, \*Automation, \*Bacteria, \*Biological treatment, \*Biological wastewater treatment, \*Chemical oxygen demand, \*Computer programs, \*Fluidized bed process, \*Montmorillonite.

Studies are made of the anaerobic digestion of olive mill wastewater (OMW) using bioreactors housing various suspended supports for immobilization of the microorganisms. The OMW inhibited the digestion as the digester loadings increased, and support medium affected the inhibition. Data were obtained by applying the international Time Series Processor (TSP) computer program version 4.0 through the Roediger equation. These data show the influence of the different supports used to immobilize the bacteria on the biometanation of OMW; this is of relevance to the development of fluidized-bed processes. Olive mill wastewater inhibits anaerobic digestion by itself, probably through some inhibitor it may contain along with biodegradable material. The inhibition was also observed in the presence of the supports tested, and was enhanced by polyvinyl chloride. The critical inhibition concentration ranged between 18 and 20 g chemical oxygen demand/L for the reference digester and for those containing saponite, Pangel and Pansil. The supports influenced both the rate of gas production and the coefficients of yields. Recommending a particular support is rather difficult as their kinetic features do not match their coefficients of yield; however, montmorillonite seems to be suitable for using media of low charge densities. (Lantz-PTT)  
W91-01055

**START-UP IN ANAEROBIC TREATMENT OF NATURAL-RUBBER EFFLUENT.** Regional Research Lab., Trivandrum (India).  
A. Pandey, L. G. Radhika, and S. V. Ramakrishna.  
Biological Wastes BIWAED, Vol. 33, No. 2, p 143-147, 3 tab, 7 ref, 1990.

**Descriptors:** \*Anaerobic digestion, \*Industrial wastewater, \*Rubber, \*Wastewater treatment, \*Bacteria, \*Biological treatment, \*Biological wastewater treatment, \*Hydrogen ion concentration, \*Methane.

In setting up an anaerobic process for industrial wastewater treatment one of the major problems is the acclimatization of the bacterial population to the particular effluent. Natural rubber industry effluent, which is a highly complex waste, can significantly upset a balanced living system which is well-set and acclimatized for biometanation. The present investigation was undertaken to focus the attention on the start-up of anaerobic digestion of natural rubber effluent, and on the problems encountered during the process. Laboratory experiments were carried out to compare the controlled and uncontrolled start-up of the anaerobic treatment of natural rubber effluent. It was found that a pH-controlled start-up was much more promising than an uncontrolled one. The biogas production was higher and a shorter period for stabilization

was required in the pH-controlled systems. (Lantz-PTT)  
W91-01056

**MECHANISMS OF COMPRESSIBLE SLUDGE CAKE SHRINKAGE.**

Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil, Environmental and Coastal Engineering.  
B. R. Bierck, and R. I. Dick.  
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 4, p 663-682, July/August 1990. 14 fig, 1 tab, 25 ref, append. NSF Grant CEE-8414614.

**Descriptors:** \*Activated sludge process, \*Filtration, \*Mathematical models, \*Sludge cake, \*Wastewater treatment, \*Filter media, \*Synchrotron X-ray fluorometry, \*Young-Laplace equation.

Shrinkage can bring about a significant consolidation of saturated filter cakes, and can result in the production of a filtrate that must be omitted from specific resistance calculations. Shrinkage results when curved air/liquid interfaces, which are bounded by solids, form at filter cake surfaces following the formation of the cake. The resultant decrease in pore water pressure is described by the Young-Laplace equation, which is used to express mathematically the effective stress which is causing shrinkage. In-situ pore water pressure measurements corroborate the onset of shrinkage of a kaolin filter cake. Synchrotron x-rays were used to monitor temporal and spatial changes in the concentration of cake-suspended solids. Significant shrinkage of an activated sludge filter cake was observed. Data on the concentration of cake-suspended solids are combined with filtrate production data to obtain singular values of the mass deposited per unit volume of filtrate of the cake-suspended solids produced by a kaolin slurry and an activated sludge. When shrinkage was ignored, calculated specific resistance values for the kaolin slurry and activated sludge were in error by 10% and 23%, respectively. If the specific resistance test is to be standardized, means for accounting for effects of shrinkage must be included. (King-PTT)  
W91-01150

**IMMOBILIZED-CELL DEGRADATION OF CHLOROPHENOLS.**

Pennsylvania Univ., Philadelphia. Dept. of Systems Engineering.  
W. K. Shieh, J. A. Puhakka, E. Melin, and T. Tuhkanen.  
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 4, p 683-697, July/August 1990. 7 fig, 24 ref.

**Descriptors:** \*Biodegradation, \*Biological wastewater treatment, \*Chlorinated hydrocarbons, \*Phenols, \*Wastewater treatment, \*Bacteria, \*Biological treatment, \*Gas chromatography, \*Mass spectrometry, \*Microcarriers, \*Organic carbon, \*Parachlorophenol, \*Phenolic pesticides, \*Secondary wastewater treatment.

The ability of immobilized cells grown under oxic and fluidized conditions to degrade 4-chlorophenol (4-CP) and 2,4-dichlorophenol (2,4-DCP) is evaluated under different dilute rate conditions. Microcarriers with 6.5 micron pores are employed for cell immobilization and retention. Results indicate that with feed 4-CP and 2,4-DCP concentrations at 35.7 and 45.3 mg/L, good and stable removal performance is achievable at empty-bed hydraulic retention times as low as one hour. Stoichiometric release of chloride and removal of total organic carbon are also observed, implying that complete mineralization of 4-CP and 2,4-DCP is attainable. This observation is further validated with gas chromatography/mass spectrometry (GC/MS) data obtained in the 2,4-DCP experimentation. Colonization of immobilized cells on the microcarrier surface is a slow but selective process. Extensive growth of filamentous bacteria is observed, with rod-shaped bacteria grown underneath and adhered to the filaments. Detachment of immobilized cells from the microcarrier surface is negligible. The formation of microbial films on the micro-

## Waste Treatment Processes—Group 5D

carrier surface with measurable thickness is absent. (Author's abstract)  
W91-01151

**FIELD PERFORMANCE OF ACTIVATED CARBON ADSORPTION FOR SEWAGE AIR.**  
National Univ. of Singapore. Dept. of Civil Engineering.  
L. C. C. Koe, and N. C. Tan.  
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 4, p 721-734, July/August 1990. 7 fig, 4 tab, 9 ref.

Descriptors: \*Activated carbon, \*Advanced wastewater treatment, \*Hydrogen sulfide, \*Odor control, \*Wastewater treatment, Carbon column, Wastewater management.

Sewage at the inlet works of a municipal wastewater treatment plant, was simultaneously pumped through two pilot columns, one filled with an alkali-impregnated carbon material, while the other was filled with a nonalkali-impregnated grade. Odor and H<sub>2</sub>S concentrations at the influent and effluent ports of the carbon columns were continuously monitored for about eight months. The odor and H<sub>2</sub>S concentrations of the influent sewage air varied significantly throughout the study period, averaging 120 standard odor units/cubic m and 5.3 ppm, respectively. Breakthrough of odor at the effluent ports occurred earlier than that for H<sub>2</sub>S, and the initial breakthrough odor was exerted mainly by non-H<sub>2</sub>S compounds. Although the alkali-impregnated carbon was capable of removing a much larger quantity of H<sub>2</sub>S than the nonalkali-impregnated grade, its effectiveness in removing other odorous but non-H<sub>2</sub>S gaseous compounds was less significant. The cost of using nonalkali-impregnated activated carbon for odor removal was comparable to that of the alkali-impregnated carbon. This cost comparison, however, ignores the effect of regeneration of the carbons. (Author's abstract)  
W91-01153

#### VIRUS REMOVAL BY SAND FILTRATION OF SEPTIC TANK EFFLUENT.

Arkansas Univ., Little Rock. Dept. of Electronics and Instrumentation.  
M. A. Gross, and D. Mitchell.  
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 4, p 711-720, July/August 1990. 3 fig, 2 tab, 16 ref.

Descriptors: \*Sand filters, \*Sand filtration, \*Septic tanks, \*Septic wastewater, \*Soil disposal fields, \*Viruses, \*Wastewater management, Enteroviruses, Physical treatment, Secondary wastewater treatment, Wastewater treatment, Water quality.

Septic tank effluent (STE) is applied to stratified sand filter columns at a rate of 6.1 cm/day or 1.5 gal/day/sq ft demonstrated the ability of the sand filter to remove enteric viruses. The sites of virus retention were determined. Seven 10-cm diameter sand columns were constructed of 2 cm of dry, coarse sand, 10 cm of dry, fine sand, and 25 cm of glass sand, with the sand layers separated by 5 cm of 1.9-cm rounded gravel. Household septic tank effluent containing poliovirus vaccine, type 1, strain LSc, is applied to the filters, and influent and effluent samples are collected. Enterovirus analyses were performed using plaque assays in buffalo green monkey kidney cell cultures. Following the filter runs, the columns were dissected into 2.5 cm discs and the discs were assayed for enteroviruses. The filter columns were found to retain all viruses when the virus loading remains less than 33,000 PFU/L (plaque-forming units per liter). Analyses of the filter discs showed that most viruses are retained in the top few centimeters of biologically active sand; mass balance reveals virus inactivation in the sand filter. (Author's abstract)  
W91-01156

**EFFECTS OF AMMONIA ON ANAEROBIC DIGESTION OF SIMPLE ORGANIC SUBSTRATES.**  
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.

D. M. Heinrichs, H. M. Poggi-Valardo, and J. A. Oleszkiewicz.  
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 4, p 698-710, July/August 1990. 6 fig, 4 tab, 25 ref, append.

Descriptors: \*Ammonia, \*Anaerobic digestion, \*Inhibition, \*Wastewater treatment, Biodegradation, Biological treatment, Biological wastewater treatment, Microbial degradation, Nitrogen, Wastewater reactors.

The effects of ammonia on mesophilic digestion of acetate, propionate, acetate-propionate mixtures and lactate were studied in batch serum bottles. The un-ionized ammonia nitrogen (UAN) affected the acetate-utilizing microorganisms in the acclimated mixed cultures to a greater extent than propionate utilizing bacteria of other trophic groups. Effects of the un-ionized ammonia on soluble organic carbon (SOC) removal and methane/biogas generation were less severe in bottles supplemented with sulfate, suggesting the development of an SOC sink mediated by sulfate-reducing bacteria. Analysis of the inhibition patterns of methane/biogas production has shown that UAN displayed a moderate half-kill dose (in the range of 10 millimoles) and demonstrated a high sensitivity exponent. This suggests the potential for a sudden failure response by an anaerobic system subjected to an increasing ammonia concentration in the reactor. (King-PTT)  
W91-01157

#### REVIEW OF OZONE GENERATING FACILITIES IN SOME U.S. WATER AND WASTEWATER TREATMENT PLANTS.

Northeast Ohio Regional Sewer District, Cleveland, OH.  
For primary bibliographic entry see Field 5F.  
W91-01165

#### UNDERSTANDING THE EFFECTS OF OZONATION ON A COMBINED MUNICIPAL/INDUSTRIAL SECONDARY EFFLUENT.

North Dakota State Univ., Fargo. Dept. of Civil Engineering.  
R. Zimmerman, and D. Richard.  
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 2, p 107-114, 1990. 5 fig, 6 ref.

Descriptors: \*Biochemical oxygen demand, \*Effluents, \*Ozonation, \*Wastewater treatment, Industrial wastewater, Municipal wastewater, Organic matter, Ozone.

An increase in the biodegradability of secondary effluent after ozonation, as measured by CBOD<sub>5</sub> (carbonaceous BOD<sub>5</sub>), generally has been considered to be due to the conversion of non-biodegradable organic material. Experiments on a specific combined municipal/industrial waste containing a high percentage of malting plant wastewater showed that an increase in CBOD<sub>5</sub> realized at the waste treatment plant was due to a shift in the oxygen uptake curve. Ozonation was found to affect both non-biodegradable and biodegradable organic matter and resulted in improved overall effluent quality despite the observed increase in CBOD<sub>5</sub>. As an indication of effluent quality, the CBOD<sub>5</sub> test is felt to be inadequate. (Author's abstract)  
W91-01166

#### EVALUATION OF EMPIRICAL PROCESS DESIGN RELATIONSHIPS FOR OZONE DISINFECTION OF WATER AND WASTEWATER.

Alberta Univ., Edmonton. Dept. of Civil Engineering.  
G. R. Finch, and D. W. Smith.

Ozone: Science and Engineering OZSEDS, Vol. 12, No. 2, p 157-175, 1990. 7 fig, 3 tab, 16 ref.

Descriptors: \*Ozonation, \*Wastewater treatment, \*Water treatment, Disinfection, Escherichia coli, Ozone, Performance evaluation, Statistical methods.

Research to examine the dose-response of Escherichia coli ATOCC 11775 in an ozone demand-free

phosphate buffer solution and in a high quality secondary wastewater effluent with a total organic carbon content of 8 mg/l and a chemical oxygen demand of 26 mg/l was undertaken. The studies were conducted in bench scale batch reactors for both water types. In addition, studies using secondary effluent also were conducted in pilot scale, semi-batch reactor to evaluate scale-up effects. It was found that the ozone dose was the most important design parameter in both types of water. Contact time was of some importance in the ozone demand-free water and had no detectable effect in the secondary effluent. Contact time was of some importance in the ozone demand-free water and had no detectable effect in the secondary effluent. Pilot plant data confirmed the results obtained at bench-scale for the secondary effluent. Regression analysis of the logarithm of the E. coli response on the logarithm of the utilized ozone dose revealed that there was lack-of-fit using the model form which has been used frequently for the design of wastewater disinfection systems. This occurred as a result of a marked tailing effect from the log-log plot as the ozone dose increased and the kill increased. It was postulated that this was caused by some unknown physiological differences within the E. coli population due to age or some other factor. (Author's abstract)  
W91-01167

#### EFFECT OF SELECTED RCRA COMPOUNDS ON ACTIVATED SLUDGE ACTIVITY.

Sirrine Environmental Consultants, Greenville, SC.

V. T. Volskay, C. P. Grady, and H. H. Tabak.  
Research Journal of the Water Pollution Control Federation JWPFAS, Vol. 62, No. 5, p 654-664, July/August 1990. 6 fig, 10 fig, 25 ref. EPA Cooperative Agreement CR-813382-01-0.

Descriptors: \*Activated sludge, \*Inhibition, \*Resource Conservation and Recovery Act, \*Wastewater treatment, Butanoic acid, Butyric acid, Chlorinated hydrocarbons, Fate of pollutants, Kinetics, Mathematical models, Model studies, Organic compounds, Respiration, Toxicity.

A pilot plant study was undertaken to better understand the fate and effects of 33 organic compounds listed in the Resource Conservation and Recovery Act (RCRA) on the activated sludge process. Eleven were insufficiently inhibitory to justify further testing and eight had responses that varied over time making it impossible to quantify their effects. The kinetic impacts of the remaining 14 (carbon tetrachloride, chlorobenzene, chloroform, 1,2-dichloroethane, 1,2-dichloropropane, 2,3-dimethyl phenol, methylene chloride, nitrobenzene, phenol, tetrachloroethylene, toluene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, and trichloroethylene) were quantified by measuring the Monod kinetic parameters for butyric acid degradation in the presence of several inhibitor concentrations using a respirometric-based assay. Attempts to model the effects of inhibitor concentration on the Monod kinetic parameters with classical linear, reversible inhibition models were unsuccessful but it was possible to model them with a general inhibition model proposed by Han and Levenspiel. (Author's abstract)  
W91-01171

#### NONPRIORITY ANALYSIS OF THE WASTEWATER STREAMS OF FOUR DYE MANUFACTURING FACILITIES.

Rutgers - The State Univ., New Brunswick, NJ. Dept. of Food Science.  
For primary bibliographic entry see Field 5A.  
W91-01172

#### GIARDIA IN WASTEWATER: EFFECT OF TREATMENT.

Pittsburgh Univ., PA. School of Engineering.  
L. W. Casson, C. A. Sorber, J. L. Sykora, P. D. Gavaghan, and M. A. Shapiro.  
Research Journal of the Water Pollution Control Federation JWPFAS, Vol. 62, No. 5, p 670-675, July/August 1990. 2 fig, 9 tab, 7 ref.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

Descriptors: \*Activated sludge, \*Giardia, \*Giardiasis, \*Human diseases, \*Secondary wastewater treatment, \*Wastewater treatment, Biological wastewater treatment, Disinfection, Primary wastewater treatment, Trickling filters, Water quality.

Giardiasis is one of the most commonly identified waterborne intestinal diseases in the U.S.A. person infected with *Giardia lamblia* may shed on the order of ten to the eighth cysts/day, which may be collected in wastewater. Studying the removal of giardia cysts by selected unit processes during wastewater treatment at three wastewater treatment plants in the U.S. was the objective of this research. Background data were obtained during a nationwide study of cyst concentration in raw and treated wastewaters. These data suggest seasonal and geographic differences in *Giardia* cyst concentrations in raw wastewater. More intensive sampling indicated that cysts are removed with varying effectiveness during primary clarification and almost completely removed in the biological treatment processes. However, a direct comparison of cyst removal efficiencies showed that cyst concentrations in the trickling filter effluent were higher than in the activated sludge process effluent. These data also suggest that cysts are concentrated in the mixed liquor suspended solids and, thus in the sludges. (Author's abstract)  
W91-01173

#### PERFORMANCE OF FOUR FULL-SCALE NITRIFYING WASTEWATER TREATMENT PLANTS INCORPORATING SELECTORS.

CH2M/Hill, Denver, CO.  
G. T. Daigger, and G. A. Nicholson.  
Research Journal of the Water Pollution Control Federation JWPFAS, Vol. 62, No. 5, p 676-683, July/August 1990. 8 fig, 2 tab, 20 ref.

Descriptors: \*Activated sludge, \*Bulking sludge, \*Nitrification, \*Secondary wastewater treatment, \*Wastewater facilities, \*Wastewater treatment, Aerobic sludge, Anaerobic sludge, Anoxic sludge, Biological treatment, Filamentous bulking, Selectors.

The effect of installing selectors to control filamentous bulking at four full-scale nitrifying wastewater treatment plants was evaluated. The results indicate that a selector can be effective in controlling filamentous bulking. Little difference in effectiveness was observed for aerobic, anaerobic, or anoxic selectors. Long-term operating data indicate that selectors, coupled with an appropriate aeration basin configuration, are capable of producing a nonbulking activated sludge with a sludge volume index (SVI) of less than 150 ml/g. Average SVI's in the 60 to 90 ml/g range can be expected with values as low as 20 to 30 ml/g observed on occasion. An aerobic selector was not effective in controlling bulking in a complete-mix nitrifying system using surface mechanical aerators. (Author's abstract)  
W91-01174

#### CHEMOSTAT STUDIES OF A MIXED CULTURE GROWING ON PHENOLICS.

Melbourne Univ., Parkville (Australia). Dept. of Microbiology.  
M. J. Hobson, and N. F. Mills.  
Research Journal of the Water Pollution Control Federation JWPFAS, Vol. 62, No. 5, p 684-691, July/August 1990. 6 fig, 2 tab, 35 ref.

Descriptors: \*Biological treatment, \*Culturing techniques, \*Growth chambers, \*Phenols, \*Secondary wastewater treatment, \*Wastewater treatment, Bacterial growth, Chemostat, Industrial wastes, Inhibition, Kinetics.

Phenolics are common constituents of aqueous effluent from coal-conversion processes, coking plants, petroleum refineries, and several chemical industries including pharmaceutical, fertilizer, and dye manufacturers. The growth of a mixed culture in a two-stage chemostat with growth limited by phenolics was studied. The first stage provided a fully viable, adapted population that was fed at a constant rate to the second stage, where the con-

centration of phenolics could be varied. The population exhibited inhibition kinetics at high concentrations of phenolics. The viability of the culture decreased with increasing dilution rate, or with increasing phenolic concentration. The nonviable population did not utilize significant amounts of substrate, but ignoring viability can lead to a significant underestimate of the growth rate. The maintenance requirements were insignificant at noninhibitory levels of phenolics, but rose to 0.15 g/g/h at inhibitory levels, possibly due to the need to repair damaged cell membranes. (King-PTT)  
W91-01175

#### ECONOMIC CONSIDERATIONS IN WASTEWATER TREATMENT WITH DUCKWEED FOR EFFLUENT AND NITROGEN RENOVATION.

Ben-Gurion Univ. of the Negev, Sede Boker (Israel). Jacob Blaustein Inst. for Desert Research. G. Oron.  
Research Journal of the Water Pollution Control Federation JWPFAS, Vol. 62, No. 5, p 692-696, July/August 1990. 4 fig, 4 tab, 18 ref.

Descriptors: \*Agronomy, \*Ammonia removal, \*Duckweed, \*Economic aspects, \*Farm wastes, \*Wastewater treatment, Agricultural engineering, Biological treatment, Domestic wastewater, Fertilizers, Irrigation.

Duckweed is one of the floating aquatic macrophytes with a preference for ammonia uptake. The ammonia is assimilated into valuable nitrogen compounds that can subsequently be used for animal feed or agricultural fertilization. Outdoor experiments were conducted in shallow miniponds which were 20 to 30 cm deep to evaluate the performance of the duckweed species, *Lemna gibba*, as a stripper for domestic wastewater. The results indicate that under adequate operational conditions the quality of accepted secondary effluents meets irrigation reuse criteria. The annual yields of dry duckweed which is harvested two to three times a week, is anticipated to be about 55 tons/ha, with a protein content close to 30%. The benefit of the additional byproduct means a reduction in wastewater expenses in the range of \$0.020 to \$0.050/cubic m. (Author's abstract)  
W91-01176

#### PERFORMANCE OF LAGOON INTERMITTENT SAND FILTER SYSTEMS.

Clemson Univ., SC. Dept. of Environmental Systems Engineering.  
L. Rich, and E. J. Wahberg.  
Research Journal of the Water Pollution Control Federation JWPFAS, Vol. 62, No. 5, p 697-699, July/August 1990. 4 tab, 7 ref.

Descriptors: \*Ammonia removal, \*Sand filters, \*Wastewater lagoons, \*Wastewater treatment, Activated sludge, Biological oxygen demand, Biological treatment, Lagoon performance, Suspended solids.

The performance of nine lagoon intermittent sand filter systems were evaluated with respect to the biological oxygen demand (BOD), total suspended solids (TSS), and NH<sub>3</sub> nitrogen removed. All systems were located either in South Carolina or Georgia and had permitted flow limits ranging from 303 cubic m/d to 12869 cubic m/d. The average 50% values for BOD, TSS and NH<sub>3</sub>-N were found to be 19, 25, 3.1 mg/L. The superior performance of the lagoon intermittent sand filter systems over aerated lagoons and most activated sludge systems was demonstrated. (Author's abstract)  
W91-01177

#### PROCESS CONTROL STRATEGY FOR THE BIOLOGICAL REDUCTION OF PHOSPHOROUS AND AMMONIA NITROGEN UTILIZING THE A/O PROCESS.

PSC Environmental Services, Limerick, PA.  
J. C. Hale.  
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 2, p 37-41, March/April 1990. 9 fig.

Descriptors: \*Activated sludge process, \*Ammonia, \*Biological wastewater treatment, \*Nitrification, \*Phosphorous removal, Regulations, \*Wastewater treatment, Advanced wastewater treatment, Process control, Sludge treatment.

The A/O Process is a process control wastewater treatment system which biologically reduces phosphorous and ammonia nitrogen without the use of chemical addition. Two currently operative treatment plants are the Patapasco WWTP in Baltimore, Maryland which utilizes this process for phosphorous removal, and the Oaks WWTP in Oaks, Pennsylvania which uses the A/O process for ammonia nitrification. Since it is much more sensitive than conventional activated sludge methods, constant monitoring is necessary to control the return and waste sludge and oxygen flows. By utilization and analysis of the indicator parameters; namely, oxygen uptake and sludge generation rates, effluent quality, and SVI, the A/O Process can be effectively controlled within each plant to achieve full compliance with NPDES permit requirements. (D'Agostino-PTT)  
W91-01187

#### WATERSHED 89: THE FUTURE FOR WATER QUALITY IN EUROPE. VOLUME II.

For primary bibliographic entry see Field 5G.  
W91-01211

#### PHYSICO-CHEMICAL TREATMENT OF WASTEWATER: EXPERIENCE AND FUTURE DEVELOPMENT.

Energy and Waste Systems Ltd., Westbury (England).  
D. E. Smith.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 307-318, 6 fig, 5 tab, 10 ref.

Descriptors: \*Coagulation, \*Lime, \*Physicochemical treatment, \*Wastewater treatment, Bacteria, Clarification, Coliforms, Disinfection, Parasites, Seawater, Sludge blanket reactors, Suspended solids, Viruses, Wastewater reactors.

Using lime-based coagulants in a high-rate upward flow blanket (UFSB) clarification process, substantial amounts of suspended solids and the biochemical load associated with these solids can be removed from sewage. Furthermore, on dilution in seawater, treated effluent from the process has shown enhanced T90 data with respect to bacteria die-off, making the process particularly effective in bacterial reduction for estuarine and marine discharge. The single stage UFSB process is extremely good at removing solids (up to 90%) from highly contaminated wastewater, and the blanket process allows results seen in laboratory settlement tests to be obtained, or even improved upon, at full scale under diurnal flow regimes. Insoluble biochemical oxygen demand is reduced and typical reductions of 50-70% have been achieved. The process can be quickly and easily retrofit to existing works to uprate performance. The removal of large populations of bacteria from sewage has resulted in Sandown Bay, England being in compliance with the European Community Directive for bathing Waters despite the short sea outfall extending only 300 meters below low water. Recent laboratory work has shown that there is great potential for the removal of salmonella, parasites, ascaris and viruses in the blanket process under the good clarification and highly alkaline conditions. Initial studies suggest that the system would enable the Engleberg guidelines for the reuse of wastewater in agriculture and aquaculture to be met in a high-rate, low-cost process as a useful alternative to stabilization ponds. (See also W91-01211) (Geiger-PTT)  
W91-01232

#### DISINFECTION AND SCREENING OF SEWAGE TO IMPROVE THE QUALITY OF BATHING WATER AT A U.K. SEASIDE RESORT.

## Waste Treatment Processes—Group 5D

Wessex Scientific Services, Bristol (England). Technical Services.  
M. J. Tarbox, and S. B. Tuckwell.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 319-330, 8 fig, 10 ref.

Descriptors: \*Disinfection, \*England, \*Swimming, \*Wastewater treatment, \*Water pollution control, \*Water quality, Chlorination, Coliforms, Environmental effects, Fish, Toxicity, Water quality control, Weston Bay.

Wessex Water's surveys highlighted the need for remedial action at Weston-super-Mare, England. A temporary scheme to disinfect sewage discharged to sea was proposed while long-term requirements were determined. Discharge water was chlorinated at the outfall site. Noncompliance with 95% limits for coliforms were noted due to tidal action and the presence of particulate matter in crude sewage that needed to be macerated to better expose bacterial populations to chlorine. Biological surveys of the intertidal regions and rocky outcrops within Weston Bay have not shown any detectable short-term effects on fauna or flora due to organochlorine formation. Tests with peracetic acid products showed that a switch to alternative disinfectants would be too costly at the present time. Trials with screens at Black Rock Pumping Station did not improve bacterial quality, but an overall improvement in the bathing water's quality is anticipated from screening. A scheme to install a flash mixer unit and contact tank is expected to further improve the quality of bathing water. (See also W91-01211) (Geiger-PTT)  
W91-01233

## WATER QUALITY STANDARDS FOR BACTERIOPHAGES.

Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).  
For primary bibliographic entry see Field 5G.  
W91-01238

## FATE OF ENTAMOEBA HISTOLYTICA DURING SEWAGE TREATMENT USING ANAEROBIC DIGESTERS.

University Coll., Cardiff (Wales). Dept. of Microbiology.  
A. E. F. Medhat, and D. A. Stafford.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 381-390, 5 fig, 2 tab, 29 ref.

Descriptors: \*Amebas, \*Anaerobic digestion, \*Protozoans, \*Sludge digestion, \*Wastewater treatment, Acetates, Escherichia coli, Fatty acids, Methane, Pollutant identification, Starch, Volatile acids.

The fate of Entamoeba histolytica was investigated during the anaerobic digestion of activated and primary sludges. Anaerobic digesters appeared to eliminate E. histolytica within hours of their addition. A close inter-relationship existed between the volatile fatty acids concentrations in the digester and E. histolytica survival. E. histolytica survived in low volatile fatty acid concentrations of 100-1,500 mg/L, but survival of the ameba declined linearly with increasing volatile fatty acids concentration. E. histolytica cell numbers died off within 12 hr in a thermophilic digester (55 °C), while still producing good methane gas quality. However, in a mesophilic digester (25-37 °C), E. histolytica survived up to 120 hr. The presence of acetate appeared to inhibit the uptake of the natural substrates of the protozoan, namely Escherichia coli cells and rice grains. Since E. histolytica can grow well in river waters and can cause disease in humans in subtropical climates, the discharge into river waters and application to land of treated sewage should be discouraged unless sufficient digestion of sludges is ensured to remove this pathogen. (See also W91-01211) (Geiger-PTT)  
W91-01241

AUTOTHERMAL FLUID BED FOR SLUDGE INCINERATION.  
SEGHERS (N.V.) Engineering, Willebroek (Belgium).  
For primary bibliographic entry see Field 5E.  
W91-01244

ANAEROBIC DIGESTION OF INDUSTRIAL AND AGRICULTURAL WASTES.  
CLEAR Ltd., Cardiff (Wales).  
S. P. Etheridge, and U. E. A. Leroff.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 417-426, 5 fig, 1 tab, 12 ref.

Descriptors: \*Anaerobic digestion, \*Farm wastes, \*Industrial wastes, \*On-site wastewater treatment, \*Waste disposal, \*Waste treatment, \*Wastewater treatment, Agricultural runoff, Europe, Fertilizers, Food-processing wastes, Manure, Municipal wastes, Sludge disposal, Solid waste disposal, Water quality standards.

The future of water quality in Europe depends on the ability to reduce the pollution load of wastewaters discharged to the environment and the subsequent ability to clean abstracted water for reuse. The prospect of European unity in 1992 will allow commercial competition for waste treatment and all European technologies in this area will become fully cross-fertilized. Increasing standards will result in increased treatment and disposal costs which will be passed on to the consumer. Anaerobic treatment systems will become an attractive option for wastewater treatment because they produce little sludge and so do not incur expensive tanking charges. Farm wastes are some of the most concentrated wastes produced and their runoff results in serious water pollution problems. Anaerobic digestion of agricultural wastes is most attractive due to its short payback time (4-5 yr). Several low cost agricultural digesters, including flexible liner digesters and fiberglass plugflow digesters, offer quicker payback periods. Due to recent advances in anaerobic digestion technology, more industrial wastewaters are becoming amenable to anaerobic treatment. These advances include the development of the fixed film reactors such as the Upflow Anaerobic Sludge Blanket and the Anaerobic Attached Film Expanded Bed digester. Moisture limitations for anaerobic digestion can now be controlled to make high solids digestion possible. As emission standards cause the costs of incineration to rise, anaerobic digestion will offer an attractive alternative for the treatment and disposal of municipal solid wastes. (See also W91-01211) (Geiger-PTT)  
W91-01245

## INDUSTRIAL EFFLUENTS: MINIMIZING ENVIRONMENTAL IMPACT.

Watson Hawksley, High Wycombe (England).  
A. V. Gray.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 427-436, 4 fig, 9 tab.

Descriptors: \*Environmental effects, \*Environmental impact, \*Industrial wastewater, \*Wastewater treatment, \*Water pollution control, Case studies, Chemical oxygen demand, Cost analysis, Food-processing wastes, Lime, Physicochemical treatment, Oil industry, Recycling, Sludge disposal, Waste characteristics, Waste disposal, Water quality standards.

The strategy and methodology employed in ensuring minimal environmental impact from the disposal of industrial effluents involves definition of the problem and all its component parts, data collection and monitoring (effluent characterization) comparison with appropriate environmental standards, evaluation of technically feasible options, and recommendations for implementation. Three case studies are reviewed to illustrate some of the problems faced. In the first case, a treated waste from a petrochemical industry was being discharged into

a small estuary without meeting water quality standards for ammonia. In this case cordial liaison between the regulatory agency and the industrialist led to an agreement to substantially improve the discharged waste quality by providing for a fully nitrified effluent, possibly by employing an extended aeration plant or an oxygen activated sludge facility to achieve the necessary 87% ammonia reduction. In the second case a building materials manufacturer experienced a buildup of waste sludge due to lime neutralization of acid scrubber gases. It was recommended that the system be operated not as a closed-loop but with a blow-down or draw-off from the recirculated water with clean water added for volume make-up. Operation of the plant in this manner permitted a stable condition to be achieved within the recirculated liquors. Studies of disposal options led to the choice to lime treat the blow down liquors, allow sufficient settlement for solids removal, and then recirculate the treated supernatants back to one of the process stages. In the third case, a food processing industry exceeded consent conditions (in particular COD) for discharging trade effluents to sewers. To remedy this situation, cost analyses and feasibility studies have demonstrated that an on-site treatment plant using physicochemical treatment plus wastes/sludge disposal off-site or sludge consolidation on site would be viable options. (See also W91-01211) (Geiger-PTT)  
W91-01246

## ADVANCED NITROGEN REMOVAL PROCESSES FOR DRINKING AND WASTE WATER TREATMENT.

Biwater Ltd., Heywood (England).  
B. Lacamp, and M. M. Bourbigot.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 437-443, 5 fig, 4 tab, 31 ref.

Descriptors: \*Biofiltration, \*Biological treatment, \*Biological wastewater treatment, \*Drinking water, \*Nitrogen removal, \*Wastewater treatment, \*Water treatment, Aeration, Aerobic digestion, Ammonia, Denitrification, Nitrates, Nutrient removal, Suspended solids.

Biological methods are commonly used for nitrogen removal in wastewater and water treatment. However, in urban areas where space is scarce, basin volume may not be sufficient for purification of activated sludges. Biological Aerated Filters (BAF), an innovative technology for plant upgrading can combine aerobic degradation of pollutants with physical retention of suspended solids in one reactor. In BAF, a high concentration of active biomass can be retained in the packed bed, while nitrifying bacteria can be attached to the filter media. Removal efficiency becomes independent of clarification and sludge settling, and ammonia oxidation can be achieved without sludge age requirements. In drinking water treatment, use of fixed film processes have become widespread for nitrate and ammonia removal due to their similarity to conventional filters. These biological processes all profit from natural phenomena of nutrient removal while reducing costs and improving water quality. (See also W91-01211) (Author's abstract)  
W91-01247

## WASTES FROM ANIMAL BREEDING: WATER QUALITY STANDARDS IN AN INTEGRATED PERSPECTIVE OF TREATMENT AND VALORIZATION FOR PORTUGAL AND SOUTHERN EUROPE.

Universidade Nova de Lisboa (Portugal). Faculdade de Ciencias e Tecnologia.  
J. Santos Oliveira, and M. I. Alves Pereira.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 445-454, 3 fig, 7 tab 23 ref.

Descriptors: \*Animal wastes, \*Feedlot wastes, \*Portugal, \*Waste recovery, \*Wastewater treat-

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

ment, \*Water pollution control, Europe, Hogs, Nutrients, Recycling, Stabilization lagoons.

Waste deriving from the raising of animals constitutes a problem which could reach serious proportions in rural areas of southern Europe. In these areas, the occurrence of dry periods justifies value-enhancement strategies for reutilization of the liquid wastes generated by animal husbandry. High-rate algal ponds (stabilization lagoons), use of wastes generated by pig farms as feed (nutrient recovery), and reutilization of liquid wastes for irrigation and fertilization make it possible to recycle a considerable proportion of the nutrients in these wastes. The standards governing the discharge of liquid wastes should take these factors into account and incorporate an ecologically-based strategy of integrated management of resources, rather than a strictly bio-destructive one. The establishment of low-energy-cost technologies for solid/liquid separation (sedimentation and filtration techniques) can help to minimize negative effects and maximize the benefits of integrated management of animal wastes. Portugal has drawn up permit requirements for pig breeders to ensure that liquid residues from raising livestock meet discharge standards. (See also W91-01211) (Geiger-PTT) W91-01248

#### CONTROL OF NITROGENOUS POLLUTION, Surrey Univ., Guildford (England). Dept. of Chemical Engineering.

M. A. Winkler, and V. S. Manoranjan.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 463-473, 4 ref.

Descriptors: \*Denitrification, \*Nitrogen removal, \*Wastewater treatment, \*Water pollution control, \*Water quality control, \*Water treatment, Ammonia, Electrodialysis, Fertilizers, Ion exchange, Nitrates, Nitrogen compounds, Physicochemical treatment, Reverse osmosis.

Nitrogen compounds found in water can contribute to many aspects of environmental pollution. In water, nitrogenous pollutants can have toxic effects, including acting as carcinogen precursors, stimulate deoxygenation and eutrophication in rivers and interfering with purification processes. Nitrogenous pollutants are very common, occurring in domestic, agricultural and industrial wastes; distributed as fertilizers and formed naturally by living organisms and lightning. Techniques for conversion and removal of nitrogen compounds from water and wastewater are well developed. In wastewater treatment, ammonia is oxidized microbiologically to nitrate, which is then removed by microbiological denitrification where sufficient substrate is available. In high-nitrogen industrial wastewaters, substrate may have to be added. A wide range of nutrient waste-products can be used for this purpose. In water purification, there may be insufficient dissolved oxygen for ammonia oxidation and/or organic substrate for microbiological denitrification. Several physicochemical methods, such as reverse osmosis, electrodialysis and ion-exchange processes are commercially available. (See also W91-01211) (Author's abstract) W91-01250

#### WATER QUALITY MANAGEMENT IN ISTANBUL: CREATING A CLEANER ENVIRONMENT.

Istanbul Water and Sewerage Administration, Turkey.  
For primary bibliographic entry see Field 5G. W91-01254

#### VARIABILITY REDUCTION MODEL FOR WASTEWATER TREATMENT.

Surrey Univ., Guildford (England). Dept. of Chemical Engineering.  
V. S. Manoranjan, and M. A. Winkler.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-

20 April, 1989. Pergamon Press, New York. 1989. p 515-518, 6 ref.

Descriptors: \*Mathematical models, \*Variability, \*Wastewater treatment, Optimization, Process control, Statistical methods, Systems analysis.

Mathematical models and controlled experiments have been useful in understanding the mechanisms of various process steps in wastewater treatment. However, it is nevertheless difficult to forecast accurately the output quality of a full-scale treatment plant from knowledge of the input to the plant due to random fluctuations in feed. Time-series models could predict the output quality as part of a feed-forward/feed-back control system, but the predicted effluent quality may not fall within the required target range. Statistical optimization techniques have been successfully used in Japan to reduce the variability of manufacturing processes. Such techniques known collectively as the Taguchi method, modify the system to reduce its sensitivity to the causes of variability, rather than attempt to control the actual sources of variability. In the Taguchi procedures, the normal and test settings of the control factors are established and the noise factors and their ranges are identified. The noise and control factor matrices are then constructed. These matrices are intelligent subsets of control and noise spaces which provide appropriate coverage of these spaces. Standard methods of statistical experimental design can be used, such as mutually orthogonal Latin squares but fractional replication and Graeco-Latin squares require less test runs. The signal to noise ratio is evaluated for each combination of variables tested, and from these data, the settings that maximize the performance measure can be predicted. Maximizing the performance measure is equivalent to reducing variability, which means that the predicted settings should also give minimum variation in the output quality of the treatment plant. In wastewater treatment, controlling the sources of variability is usually impossible or expensive. The present technique may be amenable to modifications to make it suitable for wastewater treatment processes. (See also W91-01211) (Author's abstract) W91-01255

#### ODOUR CONTROL FOR THE 1990S—HIT OR MISS.

WRc Engineering, Swindon (England).  
S. J. Toogood.  
Journal of the Institution of Water and Environmental Management JIWMEEZ, Vol. 4, No. 3, p 268-275, June 1990. 8 ref.

Descriptors: \*Biological wastewater treatment, \*Odor control, \*Public nuisance, \*Ventilation, \*Wastewater treatment, Adsorption, Air pollution control, Biofiltration, Chemical treatment, Dispersion, Model studies, Odor-producing algae, Odors, Oxidation.

A general strategy for dealing with odor problems at a sewage works, once the use of preventative measures alone has been ruled out is presented. A strategy for dealing with nuisance emphasizes a fully integrated approach, involving covering, ventilation design, and odor treatment. Some of the options for treatment are compared, including adsorption, dry oxidizing packings, wet chemical scrubbing and biological odor control processes (i.e., biofilters and bioscrubbers). The objective of any odor control scheme is to eliminate nuisance, not eliminate odors. The use of dispersion models can be used to determine the extent of remedial works, and acting early in the complaint process can result in a cost effective solution. It is concluded that biological treatment is the most generally applicable method to the sewage works. (Ver-Nooy-PTT) W91-01275

#### GRAVEL BED HYDROPONIC SYSTEMS USED FOR SECONDARY AND TERTIARY TREATMENT OF SEWAGE EFFLUENT.

Portsmouth Polytechnic (England). School of Biological Sciences.  
J. E. Butler, R. F. Loveridge, M. G. Ford, D. A. Bone, and R. F. Ashworth.

Journal of the Institution of Water and Environmental Management JIWMEEZ, Vol. 4, No. 3, p 276-284, June 1990. 5 figs, 4 tab, 9 ref.

Descriptors: \*Biofilms, \*Biological wastewater treatment, \*Contact beds, \*Gravel, \*Hydrophytes, \*Hydroponics, \*Reeds, \*Secondary wastewater treatment, \*Tertiary wastewater treatment, \*Wastewater treatment, Biochemical oxygen demand, Databases, Design criteria, Developing countries, Dolerite, Effluents, Limestone, Rural areas.

Gravel bed hydroponic (GBH) systems planted with emergent hydrophytes, such as *Phragmites australis* (the common reed), treat domestic sewage effluents to acceptable environmental standards in an economic and efficient manner. Biochemical oxygen demand (BOD), ammonia, and coliform bacteria can be reduced by over 90% and dissolved oxygen (DO) substantially increased. In temperate zones, such as Europe, GBH systems can be used to replace conventional small rural treatment works, and for tertiary treatment of final effluents. In tropical and arid zones, GBH systems can provide locally-managed, cost-effective alternatives to high-technology systems which are inappropriate for use in developing countries. In the UK, the final effluent of the biological treatment works at one site was taken as feed water for three beds of different characteristics. Samples were collected monthly to provide successive sampling cohorts. The results form a multivariate database which will be used to identify design parameters for GBH systems. In Egypt, settled sewage from Abu Attwa is used as feed water after the grit, silt and heavy solids which bypass the overloaded works have been removed by resettlement in a dedicated humus tank. Preliminary results of this secondary GBH treatment reveal significant reductions in BOD on all beds, with dolerite and limestone aggregates in 100 m channels performing most efficiently. Results from both the Egyptian and UK field-scale GBH trials have demonstrated a relationship between bed length and the extent of sewage treatment. (Ver-Nooy-PTT) W91-01276

#### DESORPTION OF ODOR SUBSTANCES FROM WATER BODIES TO THE ATMOSPHERE.

Hyogo Prefecture Environmental Science Inst., Kobe (Japan).  
For primary bibliographic entry see Field 5G. W91-01282

#### FATE OF SELECTED CHLORINATED ORGANIC COMPOUNDS DURING SEMI-CONTINUOUS ANAEROBIC SLUDGE DIGESTION.

Rentokil Ltd., East Grinstead (England). Research and Development Div.  
R. S. K. Buisson, P. W. W. Kirk, and J. N. Lester.  
Archives of Environmental Contamination and Toxicology AECTCV, Vol. 19, No. 3, p 428-432, May/June 1990. 4 tab, 25 ref.

Descriptors: \*Anaerobic digestion, \*Biological treatment, \*Chlorinated hydrocarbons, \*England, \*Pesticides, \*Sludge treatment, \*Wastewater treatment, Biodegradation, Digestion, Herbicides, Pollutants, Polychlorinated biphenyls.

The predominant sewage sludge treatment process in the United Kingdom is mesophilic anaerobic digestion. The fate of chlorinated organic micropollutants during this treatment process is, however, largely unknown. Laboratory scale simulations were applied to assess the fate of chlorophenoxy herbicides, chlorophenols, polychlorinated biphenyls, and organochlorine pesticides during the digestion of primary sludge and co-settled waste activated and primary sludge, obtained from full scale works. Incubation was carried out under non-sterile and sterile conditions. The use of a batch technique to study the anaerobic degradation of the chlorinated organic micropollutants permits observations on their rates of degradation. Previous studies have demonstrated that when degradation occurs, it is very rapid with micropollutants being completely removed within four days in

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primary digested sludge. In the case of the mixed digested sludge which did not have such a high solids concentration and a proportion of whose solids consisted of the less readily biodegradable mixed liquor solids, the rate of degradation was not as rapid. This lower inherent biodegradability was illustrated by a subsequent continuous digestion study in which gas output was lower from the mixed sludge digester. However, the rate of degradation was still sufficiently rapid to remove the micropollutants within one retention time of a typical sludge digester. (Mertz-PTT) W91-01319

#### ANAEROBIC TREATMENT OF BAKER'S YEAST WASTEWATER: II. SULFATE REMOVAL

British Columbia Univ., Vancouver. Dept. of Bio-Resource Engineering.  
K. V. Lo, A. Chen, and P. H. Liao.  
Biomass BIOME9, Vol. 23, No. 1, p 25-37, 1990. 3 fig, 3 tab, 14 ref.

Descriptors: \*Anaerobic digestion, \*Biological treatment, \*Contactors, \*Wastewater reactors, \*Sulfates, \*Wastewater treatment, Biomass, Chemical oxygen demand, Fixed-film reactor, Hydrogen ion concentration, Methane, Methanogenesis, Molasses, Wastewater, Yeasts.

The effect of sulfate removal from molasses wastewater on anaerobic digestion was studied using two reactors. One was an anaerobic rotating biological contact reactor with an active biomass developed on its support structure before the experiment commenced. The other was a new fixed-film reactor which was started without attached biomass. The experimental results showed that sulfate removal from the wastewater did not improve the gas production and treatment efficiency of the anaerobic rotating biological contact reactor. This observation indicated that sulfate-reducing bacteria could not compete with methane-producing bacteria in a well-established active biomass reactor. However, the fixed-film reactor showed significant improvement in gas production (0.17-0.66 L CH<sub>4</sub>/L reactor day) and chemical oxygen demand reduction (maximum of 44%) as a result of sulfate removal coupled with pH adjustment. Thus, the initial step of sulfate removal from molasses wastewater would appear to be essential to start up a reactor without well-developed biomass in order to enhance the slow-growing methanogens. (Author's abstract) W91-01322

#### SEPTIC SYSTEM EFFICIENCY: PARALLEL AND SERIAL METHODS FOR DISTRIBUTING EFFLUENT

Tennessee Univ., Knoxville. Dept. of Agricultural Engineering.  
C. R. Mote, F. A. Mucke, and J. S. Allison.  
Journal of Environmental Health JEVHAH, Vol. 52, No. 5, p 283-287, March/April 1990. 3 fig, 5 tab, 17 ref.

Descriptors: \*Effluents, \*Septic drain fields, \*Septic tanks, \*Soil disposal fields, \*Wastewater disposal, \*Wastewater treatment, Chemical oxygen demand, Fecal coliforms, Filtration, Groundwater pollution, Nitrogen, Phosphorus, Soil treatment.

Parallel and serial methods of distributing septic tank effluent were compared using representative soil columns. Effluent was applied to each column for a period of 63 weeks. Weekly samples of renovated effluent were evaluated for volume, chemical oxygen demand, nitrogen, phosphorus, and fecal coliform content. Although both methods of distribution allowed the soil to adequately transmit the effluent, parallel distribution increased renovation efficiency. Discharges of poor quality effluent corresponded with periodic high water discharge rate episodes observed only for serial-loaded columns. These episodes and the associated reduction in renovation efficiency suggest that filter fields with serial distribution have greater potential for polluting the groundwater than do filter fields with parallel distribution. (Author's abstract) W91-01381

#### REMOVAL OF ORGANOHALOGENS AND ORGANOHALOGEN PRECURSORS IN RECLAIMED WASTEWATER-I

California Univ., Los Angeles. Dept. of Civil Engineering.  
L. C. Bauman, and M. K. Stenstrom.  
Water Research WATRAG, Vol. 24, No. 8, p 949-955, August 1990. 5 fig, 3 tab, 21 ref. California Department of Water Resources contract no. B56726.

Descriptors: \*Disinfection, \*Halogenated hydrocarbons, \*Municipal wastewater, \*Pesticides, \*Wastewater renovation, \*Wastewater treatment, \*Water reuse, Chlorinated hydrocarbons, Chlorination, Drinking water, Organic matter, Tertiary wastewater treatment, Trihalomethanes.

A high level of treatment will be required if municipal wastewater effluents are to meet drinking water standards. Reclaimed wastewaters contain significant levels of potentially hazardous organohalogen precursors derived from surface pollution. These compounds can be measured as instantaneous total organic halogens. In addition to background contaminant removal, disinfection would be of prime importance for providing a safe product for consumption. Aqueous chlorine, a cost effective and efficient disinfectant, has come under scrutiny following the discovery of trihalomethanes in drinking water. Fractionation, using synthetic resins of dissolved organic material in filtered secondary effluent from an advanced wastewater reclamation facility and unpolluted source water (based upon acidity, solubility and adsorbability), indicated a strong correlation between organohalogen formation potential and organic carbon. Background organohalogen precursors were quantified as total organic halogens. In addition to humic substances, the classic trihalomethane precursors, hydrophilic substances that comprised the largest fraction of the dissolved material, were implicated because of their tendency to form organic halogens upon chlorination. Evaluation of an existing comprehensive advanced treatment process for reclamation of municipal wastewaters indicated that it provides a high level of treatment with respect to removal of organohalogen precursors and precursor organics. (See also W91-01416) (Mertz-PTT) W91-01415

#### REMOVAL OF ORGANOHALOGENS AND ORGANOHALOGEN PRECURSORS IN RECLAIMED WASTEWATER-II

California Univ., Los Angeles. Dept. of Civil Engineering.  
L. C. Bauman, and M. K. Stenstrom.  
Water Research WATRAG, Vol. 24, No. 8, p 957-964, August 1990. 7 fig, 2 tab, 33 ref. California Department of Water Resources contract no. B56726.

Descriptors: \*California, \*Halogenated hydrocarbons, \*Municipal wastewater, \*Pesticides, \*Wastewater renovation, \*Wastewater treatment, \*Water reuse, Air stripping, Carbon adsorption, Chlorinated hydrocarbons, Coagulation, Disinfection, Drinking water, Flocculation, Hydrogen ion concentration, Reverse osmosis, San Diego, Ultraviolet treatment.

The city of San Diego, CA has proposed to utilize reclaimed wastewater as a potential drinking water source. The proposal requires disinfecting and recycling effluent by mixing and storing the treated effluent with natural source waters in a reservoir for one year. The existing wastewater facility consists of primary treatment, secondary treatment, coagulation, flocculation, ultraviolet disinfection, reverse osmosis, air stripping and carbon adsorption. Treatment would potentially be followed with disinfection by chlorination. Treatment, at bench scale, of filtered secondary effluent from an advanced wastewater reclamation facility indicated that carbon adsorption and advanced oxidation each provide significant reductions in concentrations of both total organic halogens and organic halogen precursors. Equilibrium and batch dynamic data suggested that multicomponent adsorption of total organic halogens and precursors was favorable and pH dependent. In addition to contact time, oxidation of total organic halogens and pre-

cursors by ozone peroxide was highly dependent upon hydrogen peroxide dosages. (See also W91-01415) (Mertz-PTT) W91-01416

#### BIODEGRADATION AND SECONDARY EFFLUENT TOXICITY OF ETHOXYLATED SURFACTANTS

Eckenfelder, Inc., Nashville, TN.  
J. Patoczka, and G. W. Pulliam.  
Water Research WATRAG, Vol. 24, No. 8, p 965-972, August 1990. 5 fig, 5 tab, 25 ref, append.

Descriptors: \*Activated sludge process, \*Biodegradation, \*Surfactants, \*Wastewater treatment, Aliphatic surfactants, Aromatic surfactants, Carbon, Chemical oxygen demand, Ethylene oxide, Sludge, Toxicity.

Several aromatic and aliphatic-based, ethoxylated surfactants were tested for their biodegradability and aquatic toxicity reduction. For all the tested surfactants, almost complete primary biodegradation by the activated sludge process was achieved as measured by the cobalt thiocyanate active substances test. Aliphatic-based products demonstrated better biodegradability in terms of total organic carbon and chemical oxygen demand reduction efficiency than aromatic-based products. Toxicities of individual surfactants, their mixtures, and effluents from biological reactors treating surfactant mixtures were determined using *Mysidopsis bahia*. For aromatic-based surfactants with the same ethylene oxide molar ratio, the toxicity of the non-biodegraded, aliphatic-based product was highest for the non-ionic (unsubstituted) surfactant. Toxicities of the non-biodegraded, aliphatic-based surfactants were in the same range as those of the non-biodegraded aromatic-based products. Increasing ethylene oxide molar ratios resulted in an exponential decrease in surfactant toxicities. Biological treatment of the aliphatic-based surfactants resulted in non-toxic effluents even at high (600 ml/L) influent concentrations. Effluents from reactors treating aromatic-based surfactants demonstrated markedly higher toxicities than those from treatment of aliphatic-based products. The presence of an active group appeared to have less effect on biological effluent toxicity than did the product base structure. (Author's abstract) W91-01417

#### OXYDATION OF PHENOLS IN WATER BY HYDROGEN PEROXIDE ON ALUMINE SUPPORTED IRON (OXYDATION DES PHENOLS PAR LE PEROXYDE D'HYDROGENE EN MILIEU AQUEUX EN PRESENCE DE FER SUPPORTE SUR ALUMINE)

Poitiers Univ. (France). Lab. de Chimie de l'Eau et des Nuisances.  
For primary bibliographic entry see Field 2K. W91-01418

#### MODIFIED HARDWICKIA BINATA BARK FOR ADSORPTION OF MERCURY (II) FROM WATER

National Environmental Engineering Research Inst., Nagpur (India).  
A. M. Deshkar, S. S. Bokade, and S. S. Dara.  
Water Research WATRAG, Vol. 24, No. 8, p 1011-1016, August 1990. 11 fig, 3 tab, 17 ref.

Descriptors: \*Mercury, \*Trees, \*Wastewater treatment, Acetates, Bark, Chemical reactions, Coagulation, Formaldehyde, Hardwickia, Heavy metals, Hydrogen ion concentration, Nitrates, Waste treatment.

Mercury is commonly removed from wastewaters by chemical precipitation, conventional coagulation, lime softening, adsorption, ion exchange, and reverse osmosis. The use of modified tree barks was investigated for removal of heavy metals as early as 1941. Hardwickia binata bark was found to have a good sorption capacity for mercury (II), and color leaching was prevented and the physical characteristics of the bark improved by treatment with formaldehyde in an acidic medium. Studies indicated that the sorption of Hg(II) increases as

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the pH increases and a contact time of 2 hours was found to be optimum. Modified bark can remove most of the Hg(II) from water if its concentration is below 20 mg/L and sorption of mercury conformed to the Freundlich adsorption isotherm. The presence of light metal ions interferes with the sorption of mercury. Mg(II) at a concentration of 200 mg/L interferes with sorption to a maximum extent. Column studies showed that the capacity of the bark was 0.34 mequiv/g. In the presence of metal cations such as Pb(2+), Cd(2+), Zn(2+), and Cu(2+) the sorption of Hg(2+) was the lowest compared to other cations showing that other cations compete with Hg(2+) for sorption by the bark. Among the different anions, it was observed that sorption of mercury was maximum for acetate and nitrate (97%). The break-through sorption capacity determined by conducting a column experiment was observed to be 21 mg/g. (Mertz-PTT)  
W91-01422

**TRACER STUDY OF THE HYDRAULICS OF FACULTATIVE STABILIZATION PONDS.**  
AGAMIT S.A., Madrid (Spain). Environmental Engineering Dept.  
M. D. Moreno.  
Water Research WATRAG, Vol. 24, No. 8, p 1025-1030, August 1990. 10 fig, 2 tab, 11 ref.

Descriptors: \*Retention time, \*Stabilization ponds, \*Tracers, \*Wastewater treatment, Heavy water, Hydraulics, Model studies, Spain, Stirred tank reactor model, Water circulation.

Low-cost wastewater treatment methods have become increasingly popular in Spain in recent years, due in part to a surge in the demand for water sanitation and environmental concern in the general population. Among these methods, the most widely employed are wastewater stabilization ponds. This technique is simple, reliable and economical. It provides good-quality effluent, with a high degree of disinfection and a low content in organic matter. The hydraulic behavior of wastewater stabilization ponds operating in different regions in Spain was investigated using a stimulus-response technique. A tracer, tritiated water, was injected at the entrance of each one of the facultative ponds at five facilities. The resulting time distribution functions were used to calculate the mean hydraulic residence time and the extent of short-circuiting inside the ponds. The percentage of dead volume ranged from 10 to 42%. Treatment efficiency would thus be substantially improved by correcting these large dead volumes. The inlets and outlets of the ponds have been redesigned and are being rebuilt as remedial measures to this problem. The statistical analysis of the results indicates that the completely stirred tank reactor model can be used to represent the hydraulic behavior of all the ponds studied, at a 99% confidence level. (Mertz-PTT)  
W91-01424

**EFFECT OF FEED COMPOSITION, AEROBIC VOLUME FRACTION AND RECYCLE RATE ON NITROGEN REMOVAL IN THE SINGLE-SLUDGE SYSTEM.**

Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.  
A. Brenner, and Y. Argaman.  
Water Research WATRAG, Vol. 24, No. 8, p 1041-1049, August 1990. 6 fig, 3 tab, 10 ref, append.

Descriptors: \*Mathematical models, \*Nitrogen, \*Nitrogen removal, \*Sludge treatment, \*Wastewater treatment, Ammonia, Biomass, Chemical oxygen demand, Municipal wastes, Simulation, Waste treatment.

A recently developed and experimentally validated model was used to delineate the effects of various design and operation parameters on the performance of single-sludge systems. Model simulation resulted in charts which illustrate the mutual effects of raw feed chemical oxygen demand/ammonia ratio, aerobic volume fraction and recycle rate. The most significant phenomenon, observed experimentally and supported by the simulation, is

that increasing recycle may lead to increased effluent nitrate. This situation may occur under low raw chemical oxygen demand/ammonia ratios, whereas for high chemical oxygen demand/ammonia ratios, as in most domestic wastes, an opposite phenomenon occurs. This means that the recycle has an optimum value that depends on feed composition and on aerobic/anoxic fraction of the system. The presence of viable cells in the feed in significant numbers affects the composition of biomass in the system and the removal of nitrogen compounds. (Author's abstract)  
W91-01426

**CONTROL OF SLUDGE SETTLING CHARACTERISTICS IN THE SINGLE-SLUDGE SYSTEM, A HYPOTHESIS.**

Technion - Israel Inst. of Tech., Haifa. Faculty of Civil Engineering.  
A. Brenner, and Y. Argaman.  
Water Research WATRAG, Vol. 24, No. 8, p 1051-1054, August 1990. 2 fig, 14 ref.

Descriptors: \*Activated sludge process, \*Bulking sludge, \*Flocculation, \*Nitrogen, \*Sludge treatment, \*Wastewater treatment, Ammonia, Chemical oxygen demand, Denitrification, Denitrifying bacteria, Filamentous bacteria, Microorganisms, Sludge.

Many studies have been carried out and many models proposed in order to understand and explain the mechanisms of bulking and bioflocculation. All of these studies related sludge bulking to the different substrate utilization rates and different growth rates of the flocculent and filamentous microbes under different operational conditions. However, denitrifying ability may affect population dynamics in activated sludge processes. Operation of activated-sludge in the single-sludge mode is suggested as an operational device for the prevention of filamentous bulking. It is hypothesized that the most filamentous microbes do not possess denitrifying ability and that the denitrifying microbes possess good steeling characteristics. It is therefore concluded that nitrogen transformations within the single-sludge system play an important role in the selection of microbial population by affecting the fractionation of organic carbon removal between the aerobic and the anoxic zones. In order to improve sludge settling characteristics, the aerobic volume fraction and the recycle rate should be carefully selected, based on the influent chemical oxygen demand/ammonia ratio. (Mertz-PTT)  
W91-01427

**SIPHONING SLUDGE.**

Houston Dept. of Public Works, TX. Wastewater Div.  
V. Bahl, and J. L. Geibel.  
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 9, p 70-71, September 1990.

Descriptors: \*Civil engineering, \*Siphons, \*Sludge, \*Wastewater facilities, \*Wastewater management, Ammonia, Biological oxygen demand, Clarification, Clarifiers, Nitrogen, Scum, Suspended solids, Texas, Water quality standards.

A massive wastewater treatment expansion using automatic sludge collection systems is helping Houston grow again. Amid the boom years of the early 1970s, the city had to curtail development because of insufficient growth of wastewater treatment systems. Numerous small wastewater treatment plants became overloaded as service areas grew. Beginning in 1974, Houston set out to enlarge or upgrade 30 treatment plants, as well as to construct several new facilities for a 700 sq mi catchment area. Efficient removal of scum and floating debris became a major consideration when planning and designing new and upgraded facilities. Floating siphon sludge collection systems met the need. Floating siphon clarifiers were used at the Keegans Bayou Wastewater Treatment plant and at an addition to the Sims Bayou Wastewater Treatment plant. At the Metro Central Wastewater Treatment plant, floating siphon systems were installed in two final clarifiers as part of an expansion project. Keegans Bayou, Sims Bayou, and Metro

Central plants now typically treat wastewater that averages 200 mg/L of biological oxygen demand (BOD) and has similar levels of total suspended solids (TSS). Ammonia as nitrogen averages 15 mg/L and organic nitrogen averages 9 mg/L. Aided by the automatic sludge collection systems the three plants consistently produce treated effluent that falls well below the permissible 30-day average of 10 mg/L BOD and 15 mg/L TSS. Ammonia nitrogen levels also fall below the permissible average of 3 mg/L in summer and 5 mg/L in winter. Houston abandoned many small wastewater treatment plants. Several lift stations were built to direct flows to the new regional facilities. (Fish-PTT)  
W91-01485

**GROUTING SLIP LINERS: THE NEW INSIDE STORY.**

Halliburton Services, Houston, TX.  
L. Lee.  
Civil Engineering (ASCE) CEWRA9, Vol. 60, No. 9, p 78-80, September 1990. 1 fig.

Descriptors: \*Civil engineering, \*Grouting, \*Liners, \*Maintenance, \*Pipes, \*Sewer systems, \*Sewers, Bulkheads, Collapse, Corrosion, Design standards, Flotation, Flow system, Industrial wastewater, Materials engineering, Pipe flow, Storm drains.

One cost-effective method of repairing storm drains, industrial drains, and sanitary sewers is slip lining: slipping a new pipe inside an old one and grouting it into place. It saves time and money, and lessens repair work. Large-diameter pipe is usually slip lined with jointed pipe pushed into the old pipe; small-diameter pipe is usually slip lined with continuous pipe pushed or pulled into place. Grouting prevents a failed installation in four ways: providing support for the pipe, slowing corrosion of the existing pipe, blocking the flow of water through the annular space, and preventing long-term damage or collapse of the new liner pipe. Factors affecting the grouting operation include water in the annular space, pipeline access, profile of the existing pipe, flotation effects, the volume of grout required, and the initial cause for pipe failure. The safest method for horizontal pipe is circulation grouting, which consists of pouring grout into one end of the system and tapping off the water and air at the opposite end. Stage grouting with controlled flotation is the best method for large-diameter thin-walled pipe. The best grouting material should have low viscosity, a clean interface with water, low specific gravity, low heat of hydration, and must not segregate when poured through water. Pumping time should be long and the grout should be impermeable and continuously-mixed. The planning and design stages should include a safe external pressure limit for the pipe; bulkhead design, venting requirements, placement and number of stages; profile and map of existing line showing all surface obstructions, elevations, and pipe-run footages; and number of stages for the grouting operation. (Fish-PTT)  
W91-01486

**BALANCING THE SCADA EQUATION FOR THE FIRST-TIME USER.**

Control Mfg. Co., Belmont, CA.  
For primary bibliographic entry see Field 7B.  
W91-01564

**INDUSTRIAL PRETREATMENT: COOPERATION-TO A POINT...**

Metropolitan Waste Control Commission, St. Paul, MN.  
L. H. Hermes, and J. D. Syme.  
Water Engineering and Management WENMD2, Vol. 137, No. 8, p 40-41, August 1990. 3 fig.

Descriptors: \*Compliance, \*Industrial wastewater, \*Metropolitan water management, \*Pretreatment of wastewater, \*Wastewater facilities, \*Wastewater management, Industrial plants, Industrial wastes, Legal aspects, Metal-finishing wastes, Minnesota, Waste recovery, Water quality standards.

## Waste Treatment Processes—Group 5D

A major goal of industrial waste management is to discharge cleaner water. At the very least that means strict monitoring and enforcement. Strict enforcement of pretreatment requirements has proven to be the most effective route to a cleaner waste stream for the Industrial Waste Division of the Metropolitan Waste Control Commission, St. Paul, Minnesota, the regional wastewater treatment authority for the St. Paul-Minneapolis metropolitan area. The Commission has never been in court to battle an industrial waste violator. The use of stipulation agreements has proven to be a more effective and quicker remedy. A stipulation agreement is a legal contract entered into by the Commission and the violating industrial user, specifying the actions which will be taken to achieve compliance, and including a compliance schedule. Part of the success of industrial pretreatment efforts in the Twin Cities is due to the success of a privately-owned centralized treatment and recovery facility. Wastes handled at the facility are generated mainly by metal-plating shops and electronics manufacturing. Industrial waste control is a major issue for the 1990s. The Commission is currently preparing revisions to its waste discharge rules, and additional limits for toxic organics may be added in the future. (Fish-PTT)  
W91-01565

**START-UP OF LOW TEMPERATURE ANAEROBIC REACTORS USING FRESHWATER METHANOGENIC SEDIMENTS.**  
Universidad Autonoma de Barcelona (Spain). Unidad de Ingenieria Quimica.  
M. Bardulet, J. Cairo, and J. M. Paris.  
Environmental Technology ETLEDB, Vol. 11, No. 7, p 619-624, 1990. 3 fig, 1 tab, 19 ref. Commission of the European Communities Contract Nr. EN3B-0050-E(B).

Descriptors: \*Anaerobic digestion, \*Biogas, \*Methanogenesis, \*Sludge, \*Wastewater treatment, Biological wastewater treatment, Fluvial sediments, Sludge digestion, Spain, Substrates.

Currently anaerobic digestion processes are mainly operated at the mesophilic range of temperatures. However, recently attention has been paid to the study of low temperature anaerobic digestion, which might serve as a method for energy recovery from organic wastes. Biogas production has been observed in lake sediments, wetlands, and marshes at temperatures between 4 and 15°C. Some methanogenic species, with low optimal temperatures have been isolated from sea and lake sediments. There is ongoing research to identify and characterize methanogenic flora which develops in low-temperature environments that might be utilized as inocula. The objective of this project was to start up anaerobic digesters, at 20°C, with non-conventional inocula (fresh water sediments) to assess the feasibility of utilizing such inocula to anaerobically treat different wastewaters. This process appeared to be stable for the three substrates studied; pig manure, distillery waste and sewage sludge. The total solids concentrations for the three substrates were 40, 25, and 32 kg/cubic m, respectively. The range of organic load applied was 0.1-1.3 kg COD/cubic m/day. Biogas production ranged from 0.195 to 0.257 cubic m biogas/cubic m substrate/day, and the percentage of methane ranged from 66 to 76%. The results of this work indicate that fresh water sediments are a promising alternative to conventional anaerobic sludge for inoculating low temperature anaerobic digesters. (Korn-PTT)  
W91-01637

**HYDRAULIC SHOCK LOADINGS OF WASTEWATER TREATMENT SYSTEM TO URBAN RAINFALL-RUNOFF (EFFETS CHOCES HYDRAULIQUES DES EAUX USEES DE RUISSELLEMENT PLUVIAL URBAIN SUR UN SYSTEME DE TRAITEMENT DES EAUX).**  
Institut National de la Recherche Scientifique, Rimouski (Quebec).  
D. Couillard, and R. D. Tyagi.  
Environmental Technology ETLEDB, Vol. 11, No. 7, p 635-650, 1990. 5 fig, 1 tab, 30 ref. English Summary.

Descriptors: \*Nutrient concentrations, \*Rainfall-runoff relationships, \*Urban runoff, \*Wastewater treatment facilities, Biological wastewater treatment, Canada, Flow characteristics, Literature review, Rainfall, Runoff, Wastewater, Wastewater treatment.

During rain events, run-off waters from urban areas are carried by combined sewer systems toward wastewater treatment facilities. The characteristics of these waters are different from those of usual wastewaters especially concerning flow. A sampling program and knowledge found in literature review lead to the conclusion that variations in flow and concentrations of nutrients measured during the sampling period did not cause any important changes in the operation of a biological wastewater treatment system. (Author's abstract)  
W91-01638

#### GLUCOSE INDUCED BREAKDOWN OF ENHANCED BIOLOGICAL PHOSPHATE REMOVAL.

Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.  
J. S. Cech, and P. Hartman.  
Environmental Technology ETLEDB, Vol. 11, No. 7, p 651-656, 1990. 3 fig, 2 tab, 7 ref.

Descriptors: \*Activated sludge, \*Anaerobic digestion, \*Phosphorus removal, \*Tertiary wastewater treatment, \*Wastewater treatment, Activated sludge process, Aerobic conditions, Anaerobic conditions, Bacteria, Bacterial physiology, Biological wastewater treatment, Czechoslovakia, Substrates.

Extensive research has been conducted on anaerobic-aerobic activated sludge systems in recent years in an attempt to increase their capacity for phosphate removal from wastewater. The enhanced phosphate removal is possibly attributable to the presence of certain bacteria capable of polyphosphate accumulation under aerobic conditions. Polyphosphate stored in bacterial cells is then hydrolyzed under anaerobic conditions to provide bacteria with the energy needed for an anaerobic substrate uptake. Two laboratory anaerobic-aerobic activated sludge reactors were operated to study enhanced biological phosphate removal. They differed only in organic substrate composition. Reactor F was fed with acetate, reactor G with an acetate-glucose mixture. Both reactors were started with identical activated sludge which had an enhanced biological phosphate removal ability. During the adaptation period, this ability increased several fold in reactor F but it was completely lost in reactor G. In spite of this fact, organic substrate also disappeared from the solution during the anaerobic stage in reactor G. Interferences due to electron acceptors such as dissolved oxygen, nitrates, nitrites, and sulfates were too low to explain this phenomenon. (Author's abstract)  
W91-01639

#### REDUCTION OF TOXIC CHROMATE IN AN INDUSTRIAL EFFLUENT BY USE OF A CHROMATE-REDUCING STRAIN OF ENTEROBACTER CLOACAE.

Tokyo Univ. (Japan). Inst. of Applied Microbiology.  
H. Ohtake, E. Fujii, and K. Toda.  
Environmental Technology ETLEDB, Vol. 11, No. 7, p 663-668, 1990. 5 fig, 15 ref.

Descriptors: \*Anaerobic bacteria, \*Chromates, \*Chromium, \*Detoxification, \*Enterobacter, \*Industrial wastes, \*Wastewater treatment, Anaerobic conditions, Effluents, Heavy metals, Japan, Mutagenicity, Toxicity.

Chromate is one of the toxic heavy metals which are common pollutants and has been shown to be mutagenic in a number of bacterial systems. Wastewaters containing toxic chromate are generated in many industrial processes. Hexavalent chromium is very soluble in water and forms the divalent anions chromate and dichromate. Detoxification and removal of hexavalent chromium in an industrial effluent was investigated using *Enterobacter cloacae*. This bacterium could completely reduce chromate to less toxic trivalent chromium when appropriate nutrients were supplied to the effluent. The reduction rate was strongly dependent on the amount of added carbon and energy sources, and also on cell density. Since the reduced chromium readily formed insoluble chromium hydroxides, about 40% of the reduced chromium could be removed from the treated water by centrifugation. The important features of the bacterial reduction of toxic chromate were as follows: (1) the reduction occurred only under anaerobic conditions, (2) carbon and energy sources were required not only for the bacterial growth, but also for the reduction of chromate, (3) the reduction occurred at a neutral pH and at normal temperatures of 20-40°C, (4) the rates of reduction were proportional to cell number, and (5) the chromate reduction was inhibited to some extent by metal ions including Cu(2+), Mn(2+), and Zn(2+). (Korn-PTT)  
W91-01641

**DESIGN CONSIDERATIONS FOR WASTE WATER TREATMENT WITH WATER HYACINTH E. CRASSIPES.**  
Universidad Autonoma Metropolitana, Mexico City. Dept. de Biotecnologia.  
O. M. Hermosillo, and S. Sarquis.  
Environmental Technology ETLEDB, Vol. 11, No. 7, p 669-674, 1990. 5 fig, 3 tab, 15 ref.

Descriptors: \*Wastewater treatment, \*Wastewater treatment facilities, \*Water hyacinth, Biochemical oxygen demand, Design criteria, Maturation ponds, Mexico, Nutrients, Toxic wastes.

The use of the water hyacinth for the removal of nutrients, biochemical oxygen demand (BOD) and toxic substances has been practiced at pilot and full scale levels by many researchers. This study was conducted to provide a design methodology for wastewater treatment in water hyacinth ponds. In order to efficiently use water hyacinth ponds for nutrient removal they must be designed as maturation ponds according to the existing local conditions, which implies that secondary treatment is needed prior to the water hyacinth pond. Satisfactory removal efficiencies can be obtained by decreasing the nitrogen load input to the system. This requires a larger pond area that causes increased biomass harvesting and disposal problems. The water-hyacinth density also plays an important role. The plant must be harvested periodically to keep the population between 80 and 120 T/Ha/d which results in the optimum growth rate. Literature data was compiled with growth rate and yield measurements to develop a performance equation with two dimensionless groups indicating the system capacity for nutrient removal. It was concluded that organic loads up to 10 Kg BOD/Ha/d are critical to obtain nitrogen removal efficiencies greater than 80%. (Korn-PTT)  
W91-01642

#### MICROBIOLOGY OF FOAMING IN ACTIVATED SLUDGE PLANTS.

Bendigo Coll. of Advanced Education (Australia). Dept. of Biological and Chemical Sciences.  
J. A. Soddell, and R. J. Seviour.  
Journal of Applied Bacteriology JABAA4, Vol. 69, No. 2, p 145-176, August 1990. 8 fig, 2 tab, 227 ref.

Descriptors: \*Activated sludge, \*Activated sludge process, \*Bacteria, \*Bulking sludge, \*Flocculation, \*Foaming, \*Fungi, \*Microbiology, \*Microorganisms, \*Wastewater treatment, Actinomyces, Australia, Bacterial analysis, Bacterial biochemistry, Bacterial ecology, Bacterial physiology, Biological treatment, Microthrix, Nostoc, Sphaerotilus, Wastewater facilities.

One of the most common forms of biological treatment of sewage is the activated sludge process which is a two stage process consisting of initial aeration followed by sedimentation. An essential requirement for successful operation of a sewage treatment plant is the formation of a suitable microbe-containing floc in the aeration tank, that

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produces a clear supernatant. Foaming involves filamentous bacteria and manifests itself as a persistent viscous brown foam or scum on the surface of the mixed liquor in the aeration vessel and sometimes on the secondary clarifier. The formation of this foam prevents the proper settling of solids that is essential to the activated-sludge process. Microscopic examination of foam usually reveals a large number of branching filamentous of actinomycetes, although filamentous bacteria and even non-filamentous bacteria have been reported. Other filamentous bacteria include *Microthrix parvicella* which selectively accumulates in the foam. Other organisms reported as major constituents of foam include *Eikelboom* Type 1851, Type 0581, Type 0914, *Sphaerotilus* and *Nostocoida limicola*. This review indicates that more studies to understand the ecology, physiology and biochemistry of the organisms in the foam are needed, and micro-manipulation techniques must be used to isolate them. New specific identification techniques like DNA probes need to be developed and routinely applied to follow populations of foam causing organisms in selected treatment plants before, during, and after foaming episodes, so that changes in their levels can be detected and followed. Finally, a more complete understanding of the biological basis of foaming in activated sludge is needed. (Korn-PTT) W91-01654

**PREVIEW ANALYSIS OF NATIONAL SLUDGE SURVEY.**  
Residuals Management Technology, Inc., Madison, WI.  
For primary bibliographic entry see Field 5E. W91-01661

**COMPOST ODOR CONTROL THROUGH PROCESS OPTIMIZATION.**  
Claremont City Water/Sewer Div., NH.  
M. E. Lang, B. M. Bennett, and R. A. Jager. *Biocycle* BCYCDK, Vol. 31, No. 7, p 76-78, July 1990. 1 fig, 4 ref.

Descriptors: \*Composting, \*Odor control, \*Sludge disposal, \*Wastewater treatment.

The Claremont, New Hampshire Wastewater Treatment Facility is a four million gallon per day conventional activated sludge facility, using aerated static pile composting of raw sludge and distribution as the method of sludge management. Numerous odor complaints were received from neighbors of the composting facility. The sludge contained high total and volatile solids, partially due to waste generated from paper processing industries. In aerated static pile composting, a minimum total solids concentration of 40% is important to provide porosity and structural integrity. At the Claremont Facility, the amendment to sludge ratio was approximately 2.7 to 1 and 0.8 to 1 on a volumetric and weight basis respectively. The aeration system was designed so that each blower operated in a positive and negative mode. It was recommended that the system run in the negative mode until the temperature within the compost pile was between 55 and 65°C. Then the air flow was reversed to control temperature while optimizing stabilization and drying. The dewatering schedule and pile construction sequence were modified to insure that aeration was provided to the same day's mix. The active piles were broken down and restacked to stimulate further stabilization. No odor complaints were received in the two months following these modifications. Further planned improvements include the construction of a collection duct and biofilter to treat process air from blowers operating in the negative mode, and the use of bio-ash as an amendment within the composting process. (Miller-PTT) W91-01662

**BOROUGH OF HUNTINGDON UPGRADES ITS WASTEWATER TREATMENT FACILITIES.**  
Commonwealth Engineering and Technology, Inc., Harrisburg, PA.  
R. H. Myers, and J. H. Parks.  
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 4, p 23-27, July/August 1990. 2 fig, 3 tab.

Descriptors: \*Filtration, \*Wastewater facilities, \*Wastewater treatment, Clarification, Compliance, Filters, Huntingdon, Juniata River, Pennsylvania, Wetlands.

The Borough of Huntingdon, PA's population growth required increased public service facilities. A 3.75 MGD wastewater treatment facility was recommended. The facility consists of preliminary treatment in the form of screening and grit removal, raw wastewater pumping and distribution, primary treatment by existing clarigestion, trickling filtration, final clarification and disinfection by chlorination prior to discharge. Sludge processing consists of anaerobic digestion of primary sludge by clarigestion, gravity thickening of trickling filter sludge, lime stabilization of thickened sludge and sludge storage. Liquid sludge was hauled to approved farmland for disposal. The Borough successfully handled a design problem involving an adjacent wetlands area with the aid of the U.S. Army Corp of Engineers. Start-up commenced in June, 1988 and final effluent compliance was achieved in less than five days. The Borough was able to meet the compliance schedule and provide facilities which contribute to improving the quality of the Juniata River. (Miller-PTT) W91-01677

**EXPANSION AND UPGRADING OF THE CHALFONT-NEW BRITAIN TOWNSHIP JOINT SEWAGE AUTHORITY/BUCKS COUNTY WATER AND SEWER AUTHORITY WASTEWATER TREATMENT PLANT.**  
Chalfont-New Britain Township Joint Sewage Authority, PA.

R. L. Truman, and L. E. Ritter.  
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 4, p 31-40, July/August 1990. 4 tab.

Descriptors: \*Secondary wastewater treatment, \*Wastewater facilities, \*Wastewater treatment, Chalfont, Compliance, New Britain, Pennsylvania, Phosphate removal, Sludge treatment, Storm wastewater.

The secondary treatment plant of the Chalfont-New Britain Township Joint Sewage Authority became a regional plant when its capacity was doubled to 1.4 MGD in 1969. A 201 Facility Plan was prepared for the Authorities in 1981. Construction began in April, 1987. The Department of Environmental Resources required that secondary treatment remain in full operation during construction. The system was ready for operation by October, 1988. Sludge handling facilities included two-stage anaerobic digestion, dissolved air flotation thickening of excess activated sludge and dewatering by two belt filter presses. Biological phosphorus removal occurs in the system as the wastewater passes alternately through aerobic and anaerobic zones of the outer channel through 'luxury' phosphorus uptake. A very important special feature of the concentric channel system has been its ability to accept peak flows well beyond capacity during storm events while maintaining a high degree of operating efficiency. The Authority looks forward to producing a high quality effluent with relative ease after struggling to achieve permit compliance during the startup period. (Miller-PTT) W91-01678

**MEASUREMENT OF SURFACE TENSION IN AGRICULTURAL WASTE SLURRIES.**  
Cambridge Univ. (England). Dept. of Chemical Engineering.  
K. W. Hester, K. Niranjan, and J. F. Davidson.  
Journal of Agricultural Engineering Research JAERA2, Vol. 46, No. 2, p 147-152, June 1990. 3 fig, 7 ref.

Descriptors: \*Data interpretation, \*Farm wastes, \*Surface tension, \*Waste treatment, \*Wastewater treatment, Mathematical equations, Slurries, Solids, Viscosity, Wastewater.

An experimental method to determine the equilibrium surface tension of cattle and pig slurries are

described. The surface tension was determined by using a published modification of the 'maximum bubble pressure method': the pressure inside a spherical bubble in excess of its surrounding is measured just prior to its release into a slurry through a capillary; the surface tension is calculated using  $P = 2$  (surface tension)/radius of the curvature, where  $P$  is the maximum pressure. The method was found to be valid only at slurry solid concentrations of < 6% by weight, where measurement errors due to slurry viscosity and the influence of solids were insignificant. Slurry surface tension was found to be 0.06 to 0.07 N/m, only slightly lower than water. This method may be applied to other agricultural waste slurries, fermentation broths and domestic sewage. (Author's abstract) W91-01702

**GROWTH AND VALUE OF CHLORELLA SALINA GROWN ON HIGHLY SALINE SEWAGE EFFLUENT.**

Chinese Univ. of Hong Kong, Shatin. Dept. of Biology.  
P. K. Wong, and K. Y. Chan.  
Agriculture, Ecosystems and Environment AEENDO, Vol. 30, No. 3/4, p 235-250, April 1990. 10 tab, 46 ref.

Descriptors: \*Chlorella, \*Chlorophyta, \*Effluents, \*Fish food, \*Nutrient removal, \*Saline water, \*Tertiary wastewater treatment, \*Wastewater, \*Wastewater treatment, Algae, Amino acids, Biomass, Fish, Nitrogen, Phosphorus, Phosphorus removal, Secondary wastewater treatment.

*Chlorella salina* was successfully cultivated in secondarily treated domestic sewage effluent of high salinity (14 ppt) in an outdoor cultivation tank. Removal efficiencies of  $\text{NH}_4(+)\text{-N}$ ,  $\text{NO}_3(-)\text{-N}$ , and  $\text{PO}_4(3-)\text{-P}$  by this alga from secondarily treated sewage effluent were 89-100%, 35-66% and 100%, respectively. The high removal efficiencies of inorganic N and P means that this process can be used as a tertiary treatment. The yield of the sewage-grown algae was 5.1 g/sq m/day for a retention time of six days. The high protein content (46.8%), relatively good amino-acid profile and low metal content enabled the use of algal biomass as feed supplement for the silver carp (*Hypophthalmichthys molitrix*). The food conversion ratios (FCR) of 5% and 10% sewage-grown algae supplemented fish food were better than on the control diet (i.e. artificial fish food alone), while the FCR of 20% sewage-grown algae supplemented fish food and live sewage-grown algae alone were inferior to that on the control diet. These results indicate that cultivation of *C. salina* in secondarily treated sewage effluent of high salinity can be used as a tertiary sewage treatment to remove inorganic N and P from secondarily treated sewage effluent to reduce pollution problems and to produce algal protein suitable as a supplement for fish feed in aquaculture. (Author's abstract) W91-01708

**CONVERSION OF FAT INTO YEAST BIOMASS IN PROTEIN-CONTAINING WASTEWATER.**

Lund Univ. (Sweden). Dept. of Applied Microbiology.  
S. Rydin, G. Molin, and I. Nilsson.  
Applied Microbiology and Biotechnology AMBIDG, Vol. 33, No. 4, p 473-476, July 1990. 3 fig, 3 tab, 15 ref.

Descriptors: \*Biomass, \*Fats, \*Proteins, \*Wastewater treatment, \*Yeasts, Culture techniques, Fungi, Lipids, Methane, Methanogenesis, Sedimentation, Wastewater utilization.

*Candida tropicalis* S001 was grown on the lipid fraction of a protein-containing wastewater in order to (i) remove fat from the water, and (ii) produce yeast biomass for feed. The yeast cells were separated from the wastewater by sedimentation. Defatted wastewater was used for methane production and gave a yield of 0.3 cubic meters methane/kg reduced chemical oxygen demand. The maximum specific growth rate of *C. tropicalis*

growing on wastewater fat at pH 4.0 was 0.35/h; the fat content was decreased from 8 g/L to about 0.1 g/L within 24 h. In continuous culture a corresponding reduction was maintained at dilution rates up to 0.36/h. The effect on growth of pH, temperature, and CO<sub>2</sub> concentration was studied with triolein as the major carbon source. The maximum specific growth rate was nearly constant (0.16/h) in the pH and temperature range of 3.2-4.0 and 20-38 °C, respectively; 10% CO<sub>2</sub> was optimal for growth. Growth on triolein resulted in a biomass yield of 0.70 g dry weight/g fat. (Author's abstract) W91-01717

#### FORMATION OF PCDDs AND PCDFs BY THE CHLORINATION OF WATER.

Umea Univ. (Sweden). Inst. of Environmental Chemistry.  
For primary bibliographic entry see Field 5F.  
W91-01725

#### CITY TACKLES MAJOR SANITARY SEWER REHABILITATION WITH NEW PROCESS.

P. K. Murzyn.  
Public Works PUWOAH Vol. 21, No. 9, p 62-63, August 1990.

Descriptors: \*Engineering, \*Rehabilitation, \*Sewer systems, Cost analysis, Illinois, Polyethylene, Swagelining.

The rehabilitation of the sanitary sewer system, some portions of which were in excess of 75 years old, of the city of Wheaton, Illinois is described. Large sections of the pipelines has deteriorated structurally, and inflow and infiltration problems were common in older, more established sewer laterals and mains. To find a long term solution to the problem, the city considered three basic alternatives: open cut excavation and replacement of deteriorating pipe sections; a felt lining and epoxy resin system; and Swagelining, the polyethylene liner pipe process. The process ultimately selected was Swagelining, which is new and unproven for sanitary sewer applications. The process involves the insertion of polyethylene pipe inside existing sewer pipe to provide a tight fitting structural lining. While the costs for using Swagelining were lower than those of other methods, there were other advantages to the process, among them: (1) the use of polyethylene pipe is accepted by the Illinois EPA, (2) the pipe meets ASTM standards, which means that it has known, predictable engineering properties, (3) the insertion of the liner pipe actually increases the flow capacity of the system (by 20%), because the coefficient of friction of the polyethylene pipe is much lower than that of the original clay and concrete sections. Swagelining accounted for rehabilitating 15,000 lineal feet of sewer lines at a cost estimated at 40 percent less than traditional open cut methods in roughly half the time (3 months). Although the process had been previously untried in sanitary sewer applications, it has proven highly effective in Wheaton. (Agostine-PTT) W91-01755

#### DEGRADATION OF PHENOL BY A BACTERIAL CONSORTIUM UNDER METHANOGENIC CONDITIONS.

Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Microbiologie Appliquée.  
G. Bechard, J. G. Bisailon, R. Beaudet, and M. Sylvestre.  
Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 8, p 573-578, August 1990. 4 fig, 3 tab, 27 ref. Natural Sciences and Engineering Research Council of Canada Grant OGP002.

Descriptors: \*Bacteria, \*Biodegradation, \*Carboxylation, \*Fate of pollutants, \*Microbial degradation, \*Phenols, \*Wastewater treatment, Anaerobic conditions, Bacillus, Benzoates, Degradation products.

An anaerobic bacterial consortium was shown to carboxylate phenol to benzoate under methanogenic conditions. Benzoate accumulated in the culture medium and was completely degraded when

the incubation period was prolonged. Two potential intermediates of phenol metabolism, namely cyclohexanol and cyclohexanone, were not accumulated or transformed by the consortium. Proteose peptone must be added to the culture medium for the carboxylation of phenol to occur and glucose could not replace proteose peptone. Inhibition of methanogenesis did not affect the carboxylation of phenol and the presence or absence of hydrogen in the gaseous atmosphere did not prevent the accumulation of benzoate. The consortium was composed of various microbiological forms dominated by Gram-negative rods. Phenol-carboxylating microorganisms were evaluated to about  $> 100$  million cells/ml by using diluted inocula. These results suggest that the carboxylation of phenol is accomplished by co-metabolism and that proteose peptone or some degradation products serve as carbon and energy sources for the growth of the carboxylating bacteria, which appear to be present in large numbers in the consortium. (Author's abstract) W91-01773

#### TENTATIVE IDENTIFICATION OF ORGANIC COMPOUNDS AT THE WESTSIDE WASTEWATER TREATMENT PLANT (HIGH POINT, NC) AND IMPLICATIONS FOR AQUATIC TOXICITY.

North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.  
F. A. DiGiano, R. F. Christman, and J. F. Storm.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-185869/AS. Price codes: A06 in paper copy, A01 in microfiche. North Carolina Water Resources Research Institute, Raleigh, Completion Report No. 245, (UNC-WRRI-89-245), July 1989. 103p, 3 fig, 21 tab, 75 ref, 8 append. State Project 70062.

Descriptors: \*Organic compounds, \*Pollutant identification, \*Wastewater treatment, Biomonitoring, North Carolina, Toxicity.

After identifying an acute toxicity problem, the North Carolina Division of Environmental Management required the High Point Westside Wastewater Treatment Plant (Westside WWTP) to institute periodic biomonitoring and reduce whole effluent toxicity. This research was undertaken to provide additional information through a broad spectrum, chemical-specific approach to toxicity reduction in which potential toxicants are identified. Westside WWTP samples determined as acutely 'toxic' or 'non-toxic' by *Daphnia pulex* bioassay, effluents from six categories of industrial dischargers, and a domestic wastewater sample were analyzed for organic chemicals using continuous solvent extraction of wastewater samples and broad spectrum GC/MS analysis. An extensive data base was developed which includes aquatic toxicity data for 60 compounds and tentatively identified compounds in WWTP samples (82 out of 123 peaks were identified) and industrial effluents (about 50 for each) ranked according to their potential for contribution to toxicity. The study suggests that many compounds found in Westside WWTP influent and effluent are of industrial origin because they occur in both industrial samples and Westside WWTP samples. (USGS) W91-01826

#### EVALUATION OF THE INSTALLATION OF A SEWAGE COLLECTION SYSTEM ON WATER QUALITY IN A PRAIRIE LAKE.

Dakota State Univ., Madison, SD. Coll. of Natural Sciences.

C. K. Brashier, J. A. Janke, and J. Halbritter.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-217241/AS. Price codes: A03 in paper copy, A01 in microfiche. South Dakota State University, Brookings, Completion Report, October 1989. 38p, 18 fig, 3 tab, 3 ref. USGS Contract No. 14-08-0001-G1590-05. USGS Project No. G1590-05.

Descriptors: \*Eutrophication, \*Sewer systems, \*Wastewater collection, Eutrophic lakes, Glacial lakes, Lake Madison, Nutrients, South Dakota, Water analysis, Water quality.

From 1968-75 extensive studies supported by EPA and OWRR were done to determine the rate and extent of the aging process in Lake Madison, a 300-acre shallow glacial prairie lake surrounded by about 600 homes near Madison, South Dakota. Since then several specific things have been done to try to slow the eutrophication of the lake. In 1970 a Sanitary District was established, and this led to most of the homes around the lake installing septic tanks and disposal fields. In 1986 the sewage treatment plant for the City of Madison was totally replaced and an extensive tertiary treatment was implemented. Sewage effluent from the city is now sent to four infiltration, percolation ponds. A sewage collection system for all the homes around Lake Madison was initiated in 1987 and scheduled for completion in 1988. In order to compile a profile of selected water quality parameters in Lake Madison, Dakota State University conducted water analysis studies in Lake Madison in the summer of 1987 and also included extensive studies of Silver Creek, the main feeder stream for Lake Madison. This research was continued and expanded in the summer of 1988 through a WRI grant. The primary objectives of this research were to continue to develop base-line data prior to and during the first year that the sewage collection system is on-line, to compare collected data to the data assembled in 1969-70, and to expand and test the college's capabilities for monitoring selected water quality parameters. (USGS) W91-01862

#### TREATMENT OF CHLOROPHENOL-CONTAMINATED WATER AND SOILS USING IMMOBILIZED MICROORGANISMS.

Biotic Consultants, Inc., Carbondale, IL.  
R. L. Crawford, and T. J. Chresand.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-222241/AS. Price codes: A03 in paper copy, A01 in microfiche. Final Report, 1990. 38p, 24 fig, 1 tab, 32 ref, append. USGS Contract No. 14-08-0001-G1474.

Descriptors: \*Biodegradation, \*Biological wastewater treatment, \*Pentachlorophenol, \*Wastewater treatment, Algal, Flavobacterium, Microbial degradation, Phenols, Polyurethane.

A pentachlorophenol (PCP)-degrading Flavobacterium, a p-cresol-degrading Pseudomonas, and the lignin-degrading P. chrysosporium were all effectively immobilized in both alginate and polyurethane. The immobilized cells effectively degraded their target compounds, and the systems proved amenable to use in batch or fluidized bed reactors for degrading PCP or cresol contaminated water and soil. Polyurethane appears to be the immobilization matrix of choice for field application as it: (1) is mechanically strong; (2) stabilizes cells for long half-lives; (3) protects cells from pollutant toxicities; and (4) in the case of PCP, acts to adsorb the contaminant and localize it in the support. Electron microscopy showed that cells were likely entrapped in small pores in the foam as opposed to being covalently linked to it. A field laboratory was assembled at a wood treating site and a 40 liter fluidized bed reactor containing foam-immobilized Flavobacterium was operated for a four week trial. The system achieved approximately 75% removal of PCP with a residence time of 0.5 hours, and approximately 90% removal with a residence time of 0.8 hours. It was determined that PCP activity in the field was due to the inoculated Flavobacterium rather than indigenous organisms growing on the outside of the foam particles. (USGS) W91-01865

#### MEASURING TECHNIQUES FOR GAS/SOLID FLUIDIZED BED REACTORS (MEBTECHNIKEN FÜR GAS/FESTSTOFF-WIRBELSCHICHTREAKToren).

Hamburg Univ. (Germany, F.R.).  
J. Werther, E. U. Hartge, and D. Renner.  
Chemie-Ingenieur-Technik CITEAH, Vol. 62, No. 8, p 605-613, August 1990. 22 fig, 41 ref. English summary.

Descriptors: \*Data acquisition, \*Fluidized bed process, \*Gases, \*Measuring instruments, \*Sludge

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

treatment, \*Solids, \*Waste disposal, \*Waste treatment, Mass spectrometry, Wastewater treatment.

Significant progress has been made in the field of fluidization in recent years due to its application to the combustion of coal, sewage sludges, and other residues. These new applications have created a demand for new measuring techniques. Currently available measuring techniques for fluid mechanical properties are reviewed, ranging from simple measurements for the determination of bed expansion, to more sophisticated techniques for the determination of local solids concentrations, velocities and mass flows. Furthermore, the problem of gas sampling from fluidized bed reactors is discussed. Among others, a measuring technique based on mass spectrometry is presented for the local and instantaneous measurement of gas concentrations. (Author's abstract)

W91-01896

#### BROAD-RANGE METHODS FOR DETERMINATION OF POLLUTANTS IN WASTEWATER.

Environmental Protection Agency, Washington, DC, Industrial Technology Div.  
For primary bibliographic entry see Field 5A.  
W91-01914

#### COMPREHENSIVE HEALTH EFFECTS TESTING PROGRAM FOR DENVER'S POTABLE WATER REUSE DEMONSTRATION PROJECT.

Denver Water Dept., CO.  
W. C. Lauer, F. J. Johns, G. W. Wolfe, B. A. Myers, and L. Y. Condie.  
Journal of Toxicology and Environmental Health JTEHD6, Vol. 30, No. 4, p 305-321, August 1990.  
1 fig, 2 tab, 33 ref. EPA Contract CS-806821.

Descriptors: \*Denver, \*Drinking water, \*Potable water, \*Public health, \*Wastewater renovation, \*Wastewater treatment, \*Water reuse, \*Water treatment, Biological studies, Clarification, Colorado, Filtration, Performance evaluation, Reverse osmosis, Secondary wastewater, Toxicity, Toxicology.

A project was designed to evaluate the relative health effects of highly treated reclaimed water derived from secondary wastewater compared to Denver's present high-quality drinking water. The 1 million gallon per day (1 mgd) demonstration plant provides water to be evaluated in the studies treating unchlorinated secondary treated wastewater with the following additional processes: high pH lime clarification, recarbonation, filtration, ultraviolet irradiation, activated carbon adsorption, reverse osmosis, air stripping, ozonation and chloramination. An additional sample is obtained from the identical treatment process substituting ultrafiltration for reverse osmosis. The toxicology tests to evaluate the possible long-term health effects are chronic toxicity and oncogenicity studies in Fischer 344 rats and B6C3F1 mice and reproductive/teratology in Sprague-Dawley rats. The results of these evaluations will be correlated with microbiological, chemical, and physical test results to establish the relative quality of reclaimed water compared to all established health standards as well as Denver's pristine drinking water. (Author's abstract)

W91-01920

#### MINIMIZATION OF CHROMIUM-CONTAMINATED WASTEWATER AT A PLATING FACILITY IN THE EASTERN UNITED STATES.

Oak Ridge National Lab., TN. Chemical Technology Div.  
J. F. Walker, J. H. Wilson, and C. H. Brown.  
Environmental Progress ENVPDI, Vol. 9, No. 3, p 156-160, August 1990. 8 fig, 3 tab, 1 ref.

Descriptors: \*Chromium, \*Industrial wastewater, \*Metal-finishing wastes, \*Reverse osmosis, \*Wastewater treatment, \*Water pollution control, Pretreatment of wastewater, Water pollution treatment.

The Oak Ridge National Laboratory conducted a hazardous waste minimization program at an in-

dustrial plating facility located in the Eastern United States. Investigations at the facility indicated that chromium was the major source of contamination. Several improvements in the operation of the facility were implemented which reduced the quantity of chromium lost from the facility by 85%. The remaining chromium-contaminated wastewater streams were treated by reverse osmosis (RO) followed by evaporation of the RO concentrate for further volume reduction. Pilot-scale RO tests indicated that the gun line rinse waters could be successfully treated by RO using a 1 to 5 micron prefilter. Pretreatment of the bright-dip rinse water proved to be ineffective; however, cleaning the membrane with a 1% solution of EDTA allowed the use of RO treatment of the bright-dip rinse by oversizing the RO unit to take into account the expected loss in permeate flux. In the full-scale tests, the loss of permeate flux was restored by cleaning with a mixture of phosphoric acid. (Geiger-PTT)

W91-01947

#### BIODEGRADATION OF CHLORINATED HYDROCARBONS IN AN IMMOBILIZED BED REACTOR.

Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.  
G. P. Miller, R. J. Portier, D. G. Hoover, D. D. Friday, and J. L. Sicard.  
Environmental Progress ENVPDI, Vol. 9, No. 3, p 161-164, August 1990. 7 fig, 1 tab, 10 ref.

Descriptors: \*Biodegradation, \*Biological treatment, \*Chlorinated hydrocarbons, \*Groundwater pollution, \*Immobilized bed reactors, \*Wastewater treatment, \*Water pollution treatment, Bacteria, Mineralization, Organic solvents.

A 75 liter immobilized microbe biological reactor with a bed retention time of 20.5 hr was used in a continuous flow mode to remediate contaminated groundwater containing ethylene dichloride (EDC), tetrachloroethylene, and trichloroethylene (TCE), with EDC being the predominant contaminant. The reactor was initially seeded with Xanthobacter autotrophicus, a demonstrated halogenated aliphatic substrate utilizer. The reactor was operated for forty-two days. Material balance determinations for primary volatile aliphatics of concern indicated an average of 90.2% mineralization of EDC, 81.7% of the TCE and 64.0% of the tetrachloroethylene. In addition to X. autotrophicus, four indigenous bacterial species from the groundwater had successfully acclimated to the reactor bed. Of the five effluent isolates only two have been identified. These are X. autotrophicus and Comamonas acidovorans. (Author's abstract)

W91-01948

#### INNOVATIVE MANAGEMENT OF AN AERATED/FACULTATIVE LAGOON SUSPENDED-GROWTH BIOLOGICAL TREATMENT SYSTEM FOR HIGH STRENGTH INDUSTRIAL WASTE STABILIZATION.

Metropolitan Denver Sewage Disposal District No. 1, CO.  
T. J. Muirhead.  
Environmental Progress ENVPDI, Vol. 9, No. 3, p 174-182, August 1990. 10 fig, 6 tab, 13 ref.

Descriptors: \*Biological wastewater treatment, \*Industrial wastes, \*Stabilization lagoons, \*Waste stabilization, \*Wastewater treatment, Aerated lagoons, Aeration, Food-processing wastes, Wastewater lagoons.

The performance and kinetics of the Coors Bio-Tech aerated/facultative lagoon suspended-growth biological treatment system were examined for high strength industrial waste stabilization. The lagoon was operated in various treatment modes and over a range of organic loadings and influent wastes to demonstrate its performance capabilities for high strength industrial waste stabilization. Process stream flexibility, large reactor volume, adequate aeration, sufficient nutrients, long mean cell residence time, high buffering capacity, and healthy-recalcitrant microbial biomass significantly contribute to its excellent efficiency in high strength industrial waste stabilization. The stabil-

ization process was described by a dynamic, high-order removal rate mathematical model. The aerated lagoon maintained a continuous mode of readiness to assimilate varying loads of high strength organic wastes and varying loads of biochemical oxygen demand. Lagoon efficiency was highest when anaerobic conditions existed and slightly less under aerobic conditions. Peak performance was established at a continuous daily loading rate of approximately 4.4 kg/cu m. As organic loadings were increased, the process reached an optimum level of removal as seen in the plateau for removal rates above 8.4 kg/cu m. A simulated clarification evaluation through the use of a settleometer showed an average high suspended solids removal rate. Despite lagoon sludge settleability rates characteristic of bulking sludge conditions, excellent solids compaction and filterability properties were observed. Microbiological studies showed a stable, healthy, recalcitrant microbial biomass comprised of a well-balanced population of bacteria, fungi, protozoa, rotifers and filaments. The microbial biomass was resistive to toxicity from acute loadings of highly concentrated wastes of ammonia, sulfides, acids, caustic, and biocides. (Geiger-PTT)

W91-01950

#### REMOVAL OF ORGANICS FROM OFFSHORE PRODUCED WATERS USING NANOFILTRATION MEMBRANE TECHNOLOGY.

Texaco, Inc., Beacons, NY.  
C. A. Dyke, and C. R. Bartels.  
Environmental Progress ENVPDI, Vol. 9, No. 3, p 183-186, August 1990. 7 fig, 1 ref.

Descriptors: \*Membrane processes, \*Offshore platforms, \*Organic pollutants, \*Ultrafiltration, \*Wastewater treatment, Cleanup procedures, Oil industry, Oil pollution, Organic compounds, Pilot plants, Reverse osmosis.

A treatment process for offshore produced water that employs nanofiltration for the removal of organic pollutants was tested on offshore platforms. The membranes yielded a permeate for discharge of less than 48 mg/l freon-extractable organics at 50% recovery, while rejecting less than 20% of the NaCl when fed a produced water of up to 176 mg/L freon-extractable organics. For a standard 6.35 cm diameter by 1 meter long spiral-wound module, initial productivities at 25 C, 14.8 bar, 58,000 mg/L total dissolved solids, and 7% recovery can be expected to be as high as 1.2 cu m/day. Although more development work is needed for this application, nanofiltration membrane systems have the potential to replace flotation cells and/or carbon adsorbers on platforms where these are required. (Geiger-PTT)

W91-01951

#### PRESSURE SEWERS DESIGN CONSIDERATIONS AND ANTICIPATED MAINTENANCE.

Hill (William F.) and Associates, Inc., Gettysburg, PA.  
W. F. Hill.  
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 5, p 20-24, September/October 1990.

Descriptors: \*Design criteria, \*Pressure sewers, \*Sewer systems, \*Wastewater collection, \*Wastewater treatment, Maintenance, Pipelines, Rural areas, Septic tanks.

In rural communities with hilly terrain, pressure sewer collection and conveyance systems may be beneficial for wastewater collection. The Lake Heritage Municipal Authority and the Possum Valley Sewer Authority of Adams County, Pennsylvania are both served by pressure collection systems that are different with respect to operation and maintenance. Lake Heritage Municipal Authority uses grinder pump units and the Possum Valley Sewer Authority uses septic tank effluent pumping. Septic tank effluent pumping allows a basic form of primary treatment on the customer's property in that the solids are removed by flotation and sedimentation in a conventional septic tank then the septic tank effluent flows to a pump pit

## Waste Treatment Processes—Group 5D

where the wastewater is pumped by a one horsepower centrifugal pump to the pressurized sewer system. Almost all centrifugal grinder units are two horsepower units. Velocities in the pressure sewer lines should not be less than two feet per second. The submersible pumps, float controls, and discharge piping are housed in a subsurface basin which is secured to mass concrete to prevent flotation. The recommended piping material for the pressure sewers is polyvinyl chloride SDR 21 type pipe with O-ring fittings. The piping system should be frost protected at all locations. Sufficient plug valves should be provided throughout the collection system to facilitate maintenance and system repair. In-line cleanouts should be provided every 600 ft to provide for periodic flushing of the system and specific maintenance procedures. Terminal cleanouts must be provided at ends of the pressure system. Most pumping units will require a 220 volt, single phase service to the pump unit control panel. Grinding units may be either centrifugal grinders or displacement grinders. Grease accumulations within the grinder units require constant maintenance. For septic tank effluent, periodic pumping will be required every three to four years. Corrosion problems are common in the septic tank effluent pump units and can be reduced with the installation of a nylatron device at the base of the pedestal. Solid wastes that enter the impeller housing can cause pump failure. This problem can be alleviated by a solids retaining device. (Geiger-PTT)

W91-01964

#### APPLICATIONS OF ADVANCED MEMBRANE FILTRATION TO INDUSTRIAL WASTEWATER TREATMENT AND GROUNDWATER CLEAN-UP.

Resource Technologies Group, Inc., Morgantown, WV.

E. W. Tiepel, and J. Shorr.  
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 5, p 41-47, September/October 1990. 7 fig, 8 tab.

Descriptors: \*Industrial wastewater, \*Membrane filters, \*Wastewater treatment, \*Water pollution treatment, Chemical treatment, Fouling, Groundwater, Metal-finishing wastes, Mine wastes, Pre-treatment of wastewater, Uranium.

Recent advances in membrane technology combined with innovative pretreatment techniques have enabled certain complex wastewaters to be effectively treated to required effluent standards. The membrane is made of an inert fluorocarbon-based material and is capable of withstanding pH conditions over the entire pH range of 0-14 and can hold up under severe oxidizing or reducing conditions. The advanced membrane system is designed to operate in turbulent flow to reduce fouling. Surface fouling by organics can be controlled with the addition of organic absorbent pretreatment chemicals such as powdered activated carbon or lime in the recirculating feed stream. The membranes can be cleaned with strong acids or bases or strong oxidants. Average pore sizes of 0.1 microns are used to overcome flux rate problems. Due to the relatively large pore size of the membrane, the system cannot reduce total dissolved solids and can be used in applications where only precipitated or absorbed pollutant species are removed. For removal of dissolved species such as chloride, sulfate, and sodium, a reverse osmosis, electrodialysis, or ion exchange system is required. Three key features of the system enable it to achieve successful treatment for a wide variety of applications: chemical pretreatment of the feed, membrane design, and system cleaning. The system has been applied to the treatment of electronics and metal-finishing industrial wastes, industrial laundry wastewater cleanup and recycling, groundwater cleanup and the Uranium Mill Tailings Remedial Action Program at the Canonsburg, Pennsylvania site. (Geiger-PTT)

W91-01965

#### RECLAIMING REVERSE OSMOSIS BLOWDOWN WITH ELECTRODIALYSIS REVERSAL.

Ionics, Inc., Watertown, MA.

E. R. Reahl.

Desalination DSLNAH, Vol. 78, No. 1, p 77-89, July 1990. 5 fig, 5 tab, 3 ref, append.

Descriptors: \*Desalination wastes, \*Electrodialysis, \*Industrial wastewater, \*Reclaimed water, \*Reverse osmosis, \*Wastewater renovation, Brines, Desalination, Evaporation ponds, Feedwater treatment, Wastewater disposal.

The Electrodialysis Reversal (EDR) process is being used to reclaim waste concentrate from reverse osmosis (RO) systems for reuse as RO feedwater. The largest operating EDR-RO reclaim system is located at a major aerospace and electronics facility in the southwestern US. Design requirements and actual operation of the EDR system are discussed. The installation of EDR for reclaiming RO blowdowns, to reduce feedwater supply requirements to RO in water short areas, and EDR's reduction of waste brine volumes to evaporative ponding has been a success. The data, and the successful performance from this installation, has already generated additional applications for EDR concentration of RO blowdowns, with further inquiries on even newer potential installations. The EDR process has shown itself to be highly reliable. EDR is easy to operate, particularly with modifications made to the system for brine concentration applications. The process has not developed any intrinsic weakness in over 12,000 hours of operation at this site. (Author's abstract)

W91-01984

#### HIGH RECOVERY REVERSE OSMOSIS.

Stone and Webster Engineering Corp., Fort Lauderdale, FL.

For primary bibliographic entry see Field 3A.  
W91-01985

#### EFFECT OF PULP AND PAPER MILL EFFLUENT IRRIGATION ON CARBON DIOXIDE EVOLUTION IN SOILS.

Tamil Nadu Agricultural Univ., Coimbatore (India). Dept. of Agricultural Microbiology.

For primary bibliographic entry see Field 5E.  
W91-01987

#### MOSQUITO CONTROL IN WASTEWATER: A CONTROLLED AND QUANTITATIVE COMPARISON OF PUPFISH (CYPRINODON NEVADENSIS AMARGOSAE), MOSQUITOFISH (GAMBUSIA AFFINIS) AND GUPIES (POECILIA RETICULATA) IN SAGO PONDWEED MARSHES.

California Univ., Davis. Dept. of Wildlife and Fisheries Biology.

D. T. Castleberry, and J. J. Cech.

Journal of the American Mosquito Control Association JAMAET, Vol. 6, No. 2, p 223-228, June 1990. 2 fig, 2 tab, 25 ref.

Descriptors: \*Biological wastewater treatment, \*Insect control, \*Mosquitoes, \*Sago pondweed, \*Secondary wastewater treatment, \*Wastewater lagoons, \*Wastewater treatment, Aquatic insects, Biological treatment, Biomass, Fish food organisms, Guppies, Marsh management, Mosquitofish, Population density, Pupfish, Zooplankton.

Vascular aquatic plants can provide a remarkably efficient and inexpensive means of treating municipal, agricultural and industrial wastewater. Unfortunately, mosquito control is difficult in artificial marsh environments. The abilities of pupfish, mosquitofish and guppies to control mosquitoes in wastewater marshes was compared. Sago pondweed was planted in 210 liter fiberglass tanks through which secondary wastewater was passed at 4 to 6 ml/second. Groups of 10 to 30 fish were placed in each of 15 tanks (plus 5 controls), along with large mosquito egg rafts. All species of fish reduced mosquito emergence ( $p < 0.05$ ). When fish population densities were similar, fish reduced emergence to similar levels. As experiments progressed, guppies developed greater population densities and provided better mosquito control than mosquitofish, which developed greater densities and better control than pupfish. Fish also reduced numbers of zooplankton, and guppies in-

creased total plant biomass, suggesting fish may influence the ability of wastewater marshes to treat wastewater. (Author's abstract)  
W91-01988

#### DESIGN AND CONSTRUCTION OF TREATMENT PROCESSES FOR HIGHWAY RUNOFF IN THE FRG.

Ingenieur-Dienst-Nord, Industriestrasse 32, 2806 Oyten, Germany.

G. Lange.

The Science of the Total Environment STENDL, Vol. 93, p 499-506, April 1990. 1 fig, 11 ref.

Descriptors: \*Germany, \*Highway effects, \*Urban runoff, \*Wastewater treatment, \*Water pollution control, \*Watercourses, Drainage systems, Pollutants, Project planning, Runoff, Surface runoff, Water pollution.

Highway runoff systems used to be designed on the basis of functional and economic considerations. Due to the introduction of the Guidelines for Street Construction (RAS-Ew) drainage guidelines in 1987 by the Transport Minister of the Federal Republic of Germany (FRG), these systems are now chosen on the basis of their effects on watercourses, groundwater and the environment. The different systems for collecting and draining highway runoff are evaluated on the basis of current knowledge. These systems include infiltration basins; footings and slopes; and infiltration ditches, shafts, and wells. The natural infiltration of road surface water over a wide area is a fundamental aim. Only when this proves impossible should runoff be discharged into watercourses. This solution includes retention systems and treatment plants. The discharge of highway runoff involves both a blockage-free drainage system and a removal system which does not harm the ground below. This latter protection must be permanently assured. It is therefore the task of the engineer to plan drainage installations in such a way that road safety requirements are permanently satisfied and no damage is caused at any subsequent stage in the drainage system. (Stoehr-PTT)

W91-02001

#### DECONTAMINATION OF HIGHWAY SURFACE RUNOFF IN THE FRG.

Stuttgart Univ. (Germany, F.R.). Inst. fuer Siedlungswasserbau, Wasserguete- und Abfallwirtschaft.

For primary bibliographic entry see Field 5G.  
W91-02002

#### POLLUTANT REMOVAL BY GULLY POTS IN DIFFERENT CATCHMENT AREAS.

Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.

M. Grottker.

The Science of the Total Environment STENDL, Vol. 93, p 515-522, April 1990. 1 fig, 2 tab, 2 ref.

Descriptors: \*Catchment basins, \*Decontamination, \*Gully pots, \*Heavy metals, \*Hydraulic design, \*Model studies, \*Simulation analysis, \*Wastewater treatment, Particle size, Suspended solids, Water pollution, Water quality.

Gully pot systems have to fulfil two functions: the efficient discharge of surface water and the removal of pollutants. Since the removal efficiency is limited by the hydraulic loading, these are contrary tasks. In order to produce a more efficient design for a gully pot, about two hundred gully pots in different catchment areas have been examined and the pollutant removal analyzed. A simulation model is calibrated using these data and the model used to predict the pollutant removal and the frequency of gully pot cleansing for different kinds of gully pots. The necessary frequency of maintenance is twice a year for the dry gully pot (DGP) and once a year for the wet gully pot (WGP). Depending on the land use of the paved surface, the removal efficiency is about five to ten percent of the flushed surface pollution load for

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

the DGP and about ten to forty percent for the WGP. (Author's abstract)  
W91-02003

#### SLURRY-EXPLOSIVE PLANT WASTE WATERS: ENVIRONMENTAL IMPACT AND TREATMENT.

Ravishankar Univ., Raipur (India). Dept. of Chemistry.  
For primary bibliographic entry see Field 5C.  
W91-02008

#### BEHAVIOR OF HEAVY METALS DURING WASTEWATER TREATMENT, I. CADMIUM, CHROMIUM AND COPPER.

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.  
M. E. Goldstone, P. W. Kirk, and J. N. Lester.  
The Science of the Total Environment STENDL, Vol. 95, p 233-252, June 1990. 9 fig, 12 tab, 36 ref.

Descriptors: \*Cadmium, \*Chromium, \*Copper, \*Heavy metals, \*Sewage, \*Wastewater treatment, Activated sludge process, Chemical analysis, Particulate matter, Pollutants, Sedimentation, Sludge, Suspended solids.

Mechanisms of metal removal during sewage treatment were reviewed and the application of these mechanisms to cadmium, chromium and copper removals were discussed. Sampling was performed at Whittingham sewage treatment works (Anglian Water), Norwich, to assess the removal mechanisms of these metals with reference to partitioning between particulate and soluble phases. Mass balances were performed as a means of quality control. It was concluded that the metals were primarily associated with suspended solids. However, considerable solubilization of cadmium and copper occurred during activated sludge treatment, possibly due to the addition of anaerobic solids in the overflow from a waste activated sludge consolidation tank. Chromium was not affected in a similar manner, possibly due to a change in its valency state. The removals of cadmium, chromium and copper were within the expected range. Final effluent concentrations of copper and chromium were below a value that would ensure compliance with the environmental quality objective for the receiving water, and final effluent cadmium concentrations were within the required standards. (See also W91-02013 and W91-02014) (Author's abstract)  
W91-02012

#### BEHAVIOR OF HEAVY METALS DURING WASTEWATER TREATMENT, II. LEAD, NICKEL, AND ZINC.

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.  
M. E. Goldstone, P. W. Kirk, and J. N. Lester.  
The Science of the Total Environment STENDL, Vol. 95, p 253-270, June 1990. 8 fig, 12 tab, 30 ref.

Descriptors: \*Heavy metals, \*Lead, \*Nickel, \*Sewage, \*Wastewater treatment, \*Zinc, Activated sludge process, Chemical analysis, Particulate matter, Pollutants, Sedimentation, Sludge, Solubility, Suspended solids.

Mechanisms of metal removal during sewage treatment were reviewed and the application of these mechanisms to lead, nickel, and zinc removals were discussed. Sampling was performed at Whittingham sewage treatment works (Anglian Water), Norwich, to assess the removal mechanisms of these metals with reference to partitioning between particulate and soluble phases. Mass balances were performed as a means of quality control. It was concluded that lead was primarily associated with solids. However, it was solubilized during activated sludge treatment and this was possibly due to the addition of anaerobic solids in the overflow from a waste activated sludge consolidation tank. The soluble phases of nickel and zinc were not significantly affected by any of the processes in the works. In general, nickel removals during primary sedimentation were lower than the other metals in this study, although they were higher than those reported by other authors. The addition of re-

turned sludge liquors appeared to have a beneficial effect on lead removal during primary sedimentation by adsorbing soluble lead to the increased solids. However, removal of zinc and nickel appeared to have been unaffected by their addition. Final effluent concentrations of the three metals were below a value which would ensure compliance with the environmental quality objective of the receiving waters. (See also W91-02012 and W91-02014) (Author's abstract)  
W91-02013

#### BEHAVIOR OF HEAVY METALS DURING WASTEWATER TREATMENT, III. MERCURY AND ARSENIC.

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.  
M. E. Goldstone, C. Atkinson, P. W. Kirk, and J. N. Lester.  
The Science of the Total Environment STENDL, Vol. 95, p 271-294, June 1990. 11 fig, 11 tab, 44 ref.

Descriptors: \*Arsenic, \*Heavy metals, \*Mercury, \*Sewage, \*Wastewater treatment, Activated sludge process, Chemical analysis, Particulate matter, Pollutants, Sedimentation, Sludge, Suspended solids.

The removal mechanisms of mercury and arsenic during sewage treatment were reviewed and possible biotransformation of mercury was discussed. Sampling was performed at Whittingham sewage treatment work (Anglian Water), Norwich. Removal mechanisms were assessed with reference to partitioning between particulate and soluble phases. Further sampling and analysis was performed to determine the importance of mercury methylation. It was concluded that mercury behaved differently in the two studies, possibly due to a change in crude sewage speciation and the introduction of a picket fence thickener in the waste activated sludge consolidation tank. In situ methylation of mercury was found, especially in the presence of bacterial solids. Arsenic removals during primary sedimentation were very high, with soluble and particulate removals on a similar level. Paradoxically arsenic removals during activated sludge treatment were extremely low. (See also W91-02012 and W91-02013) (Author's abstract)  
W91-02014

### 5E. Ultimate Disposal Of Wastes

#### METAL CONTENT OF FUNGAL SPORO-CARPS FROM URBAN, RURAL, AND SLUDGE-TREATED SITES.

Pacific Northwest Forest and Range Experiment Station, Wenatchee, WA. Forestry Sciences Lab.  
For primary bibliographic entry see Field 5B.  
W91-01005

#### BATCH LEACHING STUDIES OF RUNDLE OIL SHALE.

Commonwealth Scientific and Industrial Research Organization, North Ryde (Australia). Div. of Coal Technology.

For primary bibliographic entry see Field 5B.  
W91-01010

#### BEHAVIOR OF TOLUENE ADDED TO SLUDGE-AMENDED SOILS.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.  
For primary bibliographic entry see Field 5B.  
W91-01024

#### EFFECT OF MUNICIPAL SEWAGE SLUDGE APPLICATION ON GROWTH OF TWO RECLAMATION SHRUB SPECIES IN COPPER MINE SPOILS.

Brigham Young Univ., Provo, UT. Dept. of Agronomy and Horticulture.  
For primary bibliographic entry see Field 5B.  
W91-01025

#### ADSORPTION, DEGRADATION, AND PLANT AVAILABILITY OF 2,4-DINITROPHENOL IN SLUDGE-AMENDED CALCAREOUS SOILS.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.  
For primary bibliographic entry see Field 5B.  
W91-01026

#### PLANT UPTAKE OF PENTACHLOROPHENOL FROM SLUDGE-AMENDED SOILS.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.  
For primary bibliographic entry see Field 5B.  
W91-01027

#### SORPTION AND DEGRADATION OF PENTACHLOROPHENOL IN SLUDGE-AMENDED SOILS.

New Mexico State Univ., Las Cruces. Dept. of Agronomy and Horticulture.  
For primary bibliographic entry see Field 5B.  
W91-01028

#### NITRIFICATION IN SLUDGE-AMENDED MICHIGAN FOREST SOILS.

Michigan State Univ., East Lansing. Dept. of Forestry.

A. J. Burton, J. B. Hart, and D. H. Urie.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 609-616, July/September 1990. 9 fig, 3 tab, 27 ref. U.S. EPA Cooperative Agreement S005551-01.

Descriptors: \*Fate of pollutants, \*Forest soils, \*Michigan, \*Nitrification, \*Sludge, \*Sludge utilization, Acidic soils, Digested sludge, Leaching, Nitrates, Soil cores, Soil treatment, Soil types, Waste disposal.

Net nitrification following liquid sludge application to four Michigan forest types was studied by aerobically incubating intact cores containing the forest floor and upper 10 cm of mineral soil. Significant net nitrification occurred in cores receiving surface applications of anaerobically digested municipal sludge (22.3 g N/sq m). Core nitrate N contents at 8 wk were 4.7, 5.3, 4.9, and 2.0 g/sq m for aspen (*Populus* spp.), northern hardwoods, oak (*Quercus* spp.), and pine (*Pinus* spp.) forest types, respectively. Net nitrification did not occur during 8 wk incubations of untreated control cores or cores receiving surface applications of sludge sterilized by freeze-drying (24.5 g N/sq m) or liming (25.7 g N/sq m), suggesting that the nitrifiers responsible for net nitrification in cores receiving the anaerobically digested sludge were added with the sludge. Nitrate concentration at 8 wk in cores from an oak field site receiving anaerobically digested sludge (43.0 g N/sq m) 33 mo prior to incubation was 72% of that in oak site soil cores treated immediately prior to incubation (22.3 g N/sq m), indicating that nitrifying populations introduced with sludge 33 mo prior were still viable. Nitrate content at 8 wk in oak cores was 77% lower when sludge was incorporated. Nitrate contents in incubated soil cores could not be used to directly predict nitrate concentrations in soil leachate and groundwater beneath sludge-treated plots at the four field sites. Results indicate that nitrification and potential for nitrate leaching following sludge application to acid forest soils are influenced by sludge type, forest type, and history of prior sludge applications. (Author's abstract)  
W91-01029

#### SOME PHYSICAL PROPERTIES OF STRUCTURAL AGGREGATES SEPARATED FROM ORGANIC WASTE-AMENDED SOILS.

Nigeria Univ., Nsukka. Dept. of Soil Science.  
J. S. C. Mbagwu, and A. Piccolo.  
Biological Wastes BIWAED, Vol. 33, No. 2, p 107-121, 7 tab, 28 ref. 1990.

Descriptors: \*Land disposal, \*Soil amendments, \*Soil properties, \*Soil water, Clays, Farm wastes, Loam, Organic carbon, Sludge disposal, Soil aggregates, Soil moisture retention, Waste disposal.

## Ultimate Disposal Of Wastes—Group 5E

Surface (0-20 cm) samples from five soils amended with pig slurry, sewage sludge or cattle slurry were separated into four macro-, and three micro-aggregate fractions of drysieving. Relative to the controls, these amendments decreased the apparent density and dispersibility of the aggregates, increased slightly their water-retention capacity at -0.33 MPa tension, but had no significant effect on intra-porosity and particle size distribution of the aggregates. On average, pig slurry reduced aggregate dispersibility by 34% in the sandy loam and 8% in the sandy clay loam Modena soils. Sewage sludge and cattle slurry reduced dispersibility by 41% and 26%, respectively, in the sandy loam Lamporecchio and sandy clay loam Cremona soils. The organic carbon contents of the aggregates accounted for 73-98% of variability in their tendency to disperse, whereas their silt plus clay contents accounted for 38-96% of variability in the moisture they retained at -0.03 MPa tension. (Author's abstract)

W91-01054

#### EFFECT OF IRRIGATION WITH SEWAGE EFFLUENT ON DECOMPOSITION OF LITTER IN PINUS RADIATA FORESTS.

New Zealand Forest Service, Rotorua. Forest Research Inst.

For primary bibliographic entry see Field 3C.  
W91-01067

#### PHOSPHORUS IN WATERS FROM SEWAGE SLUDGE AMENDED LYSIMETERS.

Illinois Univ., Urbana. Dept. of Agronomy.  
For primary bibliographic entry see Field 5B.

W91-01107

#### FUNDAMENTALS AND APPLICATION OF WINDROW COMPOSTING.

Black and Veatch, Irvine, CA.

J. C. Hay, and R. D. Kuchenriether.

Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 4, p 746-763, July/August 1990. 9 fig, 3 tab, 13 ref.

Descriptors: \*Composting, \*Sludge disposal, \*Waste disposal, \*Windrow composting, Aeration, Los Angeles, Odor control, Sludge, Sludge cake, Sludge digestion.

The conventional windrow and aerated windrow processes are viable sludge disposal options that produce marketable end products. Both methods entail constructing long parallel rows containing a mixture of sludge cake and amendment and turning the rows frequently with mobile equipment. The conventional process relies on natural ventilation whereas the aerated method uses forced mechanical aeration in addition to natural ventilation. Major drawbacks of the conventional process include excess odor generation and susceptibility to upset from adverse weather. Odor control is a major advantage of aerated windrow composting; these systems, however, are more capital intensive than the simpler conventional systems. The Sanitation Districts of Los Angeles County, CA, operate a state-of-the-art conventional windrow facility at the Joint Water Pollution Control Plant in Carson, CA. The operation uses two composting steps and two different composting machines. Quality control monitoring has shown that the two-step method provides excellent disinfection and produces a dry product during most of the year. Rainy weather and cool air temperatures reduce the drying rate, resulting in the production of a wetter compost during the winter. (Author's abstract)

W91-01154

#### IMMOBILIZATION MECHANISMS IN SOLIDIFICATION/STABILIZATION OF CD AND PB SALTS USING PORTLAND CEMENT FIXING AGENTS.

Louisiana State Univ., Baton Rouge. Dept. of Chemistry.

For primary bibliographic entry see Field 5G.  
W91-01182

#### BIOTESTING OF WASTEWATER: A COMPARATIVE STUDY USING THE SALMONELLA AND CHO ASSAY SYSTEMS.

Oak Ridge National Lab., TN. Biology Div.  
L. C. Waters, R. L. Schenley, B. A. Owen, P. J. Walsh, and A. W. Hsie.  
Environmental and Molecular Mutagenesis EMMUEG, Vol. 14, No. 4, p 254-263, 1989. 1 fig, 9 tab, 22 ref. EPA Interagency Agreement 40-1534-84 and DOE contract DE-AC05-84OR21400.

Descriptors: \*Bioassay, \*Mutagenicity, \*Pollutant identification, \*Toxicity, \*Wastewater analysis, Chinese hamster ovary test, Clean Water Act, Cytotoxicity, Risk assessment, Salmonella.

Reliable procedures for the assessment of the toxicity of wastewaters are essential to implementing the Federal Clean Water Act. Health risk determination is limited to those chemicals for which toxicity data are available. Since long-term whole animal tests on large numbers of wastewater samples are impractical, shorter, cellular-based assays are necessary. The evaluation of two short-term bioassays indicated that the Salmonella test is the more sensitive indicator of mutagenic activity, whereas the Chinese hamster ovary (CHO) test is a sensitive detector of the presence of cytotoxic components in wastewater concentrates. Complementary use of multiple bioassays and concentration methods is necessary for the optimal detection and characterization of toxic components in wastewater. (D'Agostino-PTT)

W91-01184

#### AUTOTHERMAL FLUID BED FOR SLUDGE INCINERATION.

SEGHERS (N.V.) Engineering, Willebroek (Belgium).

H. A. Masson.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 405-416, 7 fig, 6 tab, 2 ref.

Descriptors: \*Fluidized beds, \*Incineration, \*Sludge disposal, \*Waste disposal, \*Waste treatment, \*Wastewater treatment, Capital costs, Design criteria, Energy costs, Environmental effects, Fly ash, Operating costs.

For large communities, incineration offers an attractive approach to sludge disposal because there is no need to stabilize the sludge, there is no need of nutrients, the waste volume reduction is tremendous, the end product is biologically and chemically inert (ash), the pathogens are completely destroyed, and the transport costs are reduced if not eliminated. Autothermal (without external fuel) incineration of sewage sludge is possible at 850 C if the air is preheated to 650 C and if the dry solid content of the sludge is at least 35% (for an organic fraction in the solids of about 65%). In order to maintain reasonable operating costs, the needed thermal energy supply for drying must be generated in the system itself. In the 'Zerofuel' process a multistage tray dryer does the required sludge drying with heat generated from flue gases. The system offers easy process control for the furnace and dryer and reduces sludge vapors by thermal cracking in the fluidized bed furnace. Flue gas analysis of the Zerofuel process at the Bruges, Belgium, plant showed that only the dust load and the SOx content exceeded the emission standards of 1986. The dust load can be further reduced by installing a third field in the electrostatic precipitator. SOx could easily be removed by introducing limestone in the bed. Washing with amines or a granular filter could be used to control mercury emissions. The system is set up in modular fashion so that various parts of the system can be taken out of operation and used elsewhere. The most sensitive parameters affecting cost of sludge incineration in the Zerofuel system are the nominal capacity, the load factor, the operating hours per year, and the quality of the sludge and its initial dry solids content. (See also W91-01211) (Geiger-PTT)

W91-01244

#### ANAEROBIC DIGESTION OF INDUSTRIAL AND AGRICULTURAL WASTES.

CLEAR Ltd., Cardiff (Wales).

For primary bibliographic entry see Field 5D.  
W91-01245

#### INDUSTRIAL EFFLUENTS: MINIMIZING ENVIRONMENTAL IMPACT.

Watson Hawksley, High Wycombe (England).

For primary bibliographic entry see Field 5D.  
W91-01246

#### EFFECTS AND BEHAVIOUR OF POLLUTANTS DURING ARTIFICIAL GROUNDWATER RECHARGE.

Institut fuer Wasserforschung G.m.b.H., Dortmund (Germany, F.R.).

For primary bibliographic entry see Field 5B.  
W91-01251

#### APPRAISAL OF THE POTENTIAL HEALTH IMPACTS OF SEWAGE DISPOSAL TO UK COASTAL WATERS.

Saint David's Univ. Coll., Lampeter (Wales). Centre for Research into Environment and Health.

For primary bibliographic entry see Field 5B.  
W91-01278

#### SITE SEWAGE DISPOSAL: THE IMPORTANCE OF THE WET SEASON WATER TABLE.

Illinois Univ., Urbana. Dept. of Agronomy.

T. J. Bicki, and R. B. Brown.

Journal of Environmental Health JEVAH, Vol. 52, No. 5, p 277-279, March/April 1990. 28 ref.

Descriptors: \*Groundwater pollution, \*On-site waste disposal, \*Seasonal variation, \*Soil disposal fields, \*Waste disposal, \*Wastewater treatment, \*Water level, \*Water pollution control, \*Water pollution prevention, \*Water table, Aeration, Bacteria, Biodegradation, Filtration, Land disposal, On-site wastewater treatment, Viruses.

Effluent entering an on-site disposal system may contain varying combinations and amounts of potential contaminants. A vertical separation distance of 24 inches between the bottom of a soil absorption system and the seasonally high water table has been suggested as a minimum soil depth for the proper treatment of effluent, and the protection of groundwater. The effluent must pass through an unsaturated zone of soil to insure good aeration and slow travel, both of which are needed to achieve good composition of organic materials, biodegradation of detergents, adsorption of effluent constituents to soil particles, die-off bacteria and viruses, and other processes contributing to the filtration and treatment of effluent. Depth to the wet season water table can be monitored with observation wells or can be estimated from soil morphological characteristics. Caution is advised when evaluating artificial drainage as a method to improve the performance of on-site sewage disposal systems. (Lantz-PTT)

W91-01379

#### SEPTIC SYSTEM EFFICIENCY: PARALLEL AND SERIAL METHODS FOR DISTRIBUTING EFFLUENT.

Tennessee Univ., Knoxville. Dept. of Agricultural Engineering.

For primary bibliographic entry see Field 5D.  
W91-01381

#### EXAMINATION AND CHEMICAL TREATMENT OF INDUSTRIAL SOLID WASTES FOR SAFE LAND APPLICATION. I. EVALUATION OF TOXIC ELEMENTS PRESENT IN SOLID WASTES FROM A FERTILIZER AND CHEMICAL PLANT.

Thessaloniki Univ., Salonika (Greece). Environmental Pollution Control Lab.

A. Katzika, and T. Koumizis.

Science of the Total Environment STENDL, Vol. 91, p 97-105, February 1990. 6 fig, 2 tab, 8 ref.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5E—Ultimate Disposal Of Wastes

**Descriptors:** \*Chemical analysis, \*Chemical treatment, \*Chemical wastes, \*Fertilizers, \*Industrial wastes, \*Land disposal, \*Solid wastes, \*Toxic wastes, \*Waste treatment, Arsenic, Chemical industry, Chemical sludge, Greece, Hydrogen ion concentration, Industrial wastewater, Laboratory methods, Pollutant identification, Solubility, Sulfuric acid, Toxicity, Water pollution sources.

Approximately 600,000 tons of solid wastes is generated annually by industries in the Thessaloniki area, of which about 65% is produced by a fertilizer chemical plant. Four solid wastes (sludge from the treatment of sulfuric acid production wastewater, ash from the roasting of iron pyrites, waste from a fertilizer unit, anhydrite produced by hydrofluoric acid and propellants production) from this plant are examined using the U.S. Environmental Protection Agency's (EPA) extraction procedure for toxicity in order to determine their content of toxic elements. Analysis of the extracts indicate that one of the samples generates arsenic at a concentration which exceeds the EPA criterion level for this element by nearly 50 times. Another sample is characterized by pH values that are below the EPA minimum values; however, the toxic element concentration does not exceed EPA limits. The extractability of toxic elements from the solid wastes using various extracting solutions is also examined in order to determine the chemical conditions under which the toxic compounds are soluble. (Author's abstract)

W91-01452

#### CONSOLIDATION AND CONTAMINANT MIGRATION IN A CAPPED DREDGED MATERIAL DEPOSIT.

Army Engineer Waterways Experiment Station, Vicksburg, MS.  
J. M. Brannon, and M. E. Poindexter-Rollings.  
Science of the Total Environment STENDL, Vol. 91, p 115-126, February 1990. 6 fig, 3 tab, 14 ref.

**Descriptors:** \*Dredging wastes, \*Ocean dumping, \*Path of pollutants, \*Solid waste disposal, \*Spoil disposal, \*Waste containment, \*Water pollution sources, Aroclors, Diffusion, Lead, Marine sediments, Polychlorinated biphenyls, Sediment contamination, Solute transport, Washington.

The effectiveness of capping contaminated dredged material was investigated in a subaqueous depression in the Duwamish Waterway in Seattle, Washington. The disposal site consisted of a previously dredged depression located in approximately 22 m of water. Field studies were conducted to evaluate the consolidation of the capped material as well as the movement of contaminants from the dredged material into the uncontaminated cap material. Results showed that most of the dredged material consolidation at this site occurred during the first 2 weeks following capping. Monitoring of contaminant concentrations in the capped deposit for 18 months showed no movement of contaminants from the dredged material into the capping material. Data for Pb and Aroclor 1242 indicate that the dredged and cap materials formed a sharp, relatively unmixed interface over the 18 months of the study. (Author's abstract)

W91-01453

#### BASIC MODEL OF WATER- AND GAS-FLOW THROUGH SMECTITE CLAY BUFFERS.

Clay Technology A.B., Lund (Sweden). Ideon Research Center.  
For primary bibliographic entry see Field 2G. W91-01458

#### SUSTAINABLE RATES OF SEWAGE SLUDGE FOR DRYLAND WINTER WHEAT PRODUCTION: I. SOIL NITROGEN AND HEAVY METALS.

Colorado State Univ., Fort Collins. Dept. of Agronomy.  
R. N. Lerch, K. A. Barbarick, D. G. Westfall, R. H. Follett, and T. M. McBride.  
Journal of Production Agriculture, Vol. 3, No. 1, p 60-65, January/March 1990. 2 fig, 7 tab, 23 ref.

**Descriptors:** \*Agricultural engineering, \*Colorado, \*Heavy metals, \*Nitrogen, \*Sludge disposal,

\*Sludge utilization, \*Wheat, Cadmium, Copper, Cycling nutrients, Fertilization, Groundwater pollution, Lead, Nickel, Nitrates, Organic loading, Root zone, Zinc.

The application of sewage sludge to agricultural land has become the major method of sludge disposal in the US. Therefore, the long-term impact of sludge application to the soil environment must be investigated in order for proper loading rates to be employed. Thus, a field study was initiated in 1982 in Colorado, with the goal of evaluating the effects of sewage sludge on soil N, Zn, Cu, Cd, Ni, and Pb levels in a dryland wheat-fallow management system compared to commercial NH<sub>4</sub>NO<sub>3</sub> fertilizer. Sewage sludge application resulted in increased soil NO<sub>3</sub>-N levels at harvest compared with the N fertilizer for all depths sampled and each year reported. The soil NO<sub>3</sub>-N in the root zone data showed that three sludge applications of 12 ton/acre resulted in significantly higher NO<sub>3</sub>-N levels throughout the root zone compared with the control of 50 lb N/acre. A loading rate of 3 ton/acre resulted in significantly greater NO<sub>3</sub>-N than the control at the 0 to 8-inch and 24 to 35-inch depths. Sludge application, at all loading rates tested, resulted in significantly increased NH<sub>4</sub>HCO<sub>3</sub>-diethylenetriaminepentaacetic acid extractable concentrations of Zn, Cu, Cd, Ni, and Pb compared to the control in the surface 8 inches of the soil. Because of the potential for NO<sub>3</sub> contamination of groundwater (and metal buildup in the soil) by the higher sludge loading rates, a loading rate of 3 ton/acre is recommended as the maximum safe loading rate for this dryland wheat system. (See also W91-01504) (Author's abstract)

W91-01503

#### SUSTAINABLE RATES OF SEWAGE SLUDGE FOR DRYLAND WINTER WHEAT PRODUCTION: II. PRODUCTION AND INCOME.

Colorado State Univ., Fort Collins. Dept. of Agronomy.  
R. N. Lerch, K. A. Barbarick, D. G. Westfall, R. H. Follett, and T. M. McBride.  
Journal of Production Agriculture, Vol. 3, No. 1, p 66-71, January/March 1990. 4 tab, 23 ref.

**Descriptors:** \*Agricultural engineering, \*Colorado, \*Cost analysis, \*Cycling nutrients, \*Fertilizers, \*Grain crops, \*Sludge disposal, \*Sludge utilization, \*Wheat, Cadmium, Crop production, Farm income, Fertilization, Groundwater pollution, Lead, Nickel, Nitrates, Nitrogen, Nutrients, Phosphorus, Zinc.

The increased production of sewage sludge in the US has led to many municipalities to consider the application of sludge to agricultural land as a feasible means of sludge disposal and nutrient recycling. A long-term field study was initiated in 1982 in Colorado, with the objective of evaluating the effects of sewage on gross income, yields, grain protein, and elemental content of dryland winter wheat compared to commercial NH<sub>4</sub>NO<sub>3</sub> fertilizer. Sludge application has produced greater gross income than N fertilizer treatments primarily due to the premiums paid for high protein grain. Application of the 3 ton/acre sludge rate resulted in an average of \$45/acre/year increase in income compared to the commonly used N rates of 50 to 60 lb N/acre. In two of the three years, neither the sludge nor the N fertilizer treatments resulted in significant yield responses. Sludge application has resulted in greater soil NH<sub>4</sub>-N and NO<sub>3</sub>-N compared to the N fertilizer treatments at boot stage over the last three years. However, because of the potential for NO<sub>3</sub> contamination of groundwater due to oversupply of N (and the potential for metal buildup in the soil) by the 12 and 18 ton/acre rates, the lower sludge rate of 3 ton/acre is recommended for this dryland wheat production system. Grain levels of P and Zn have been increased by sludge application while the concentrations of Cd, Ni, and Pb have remained very low. (See also W91-01503) (Author's abstract)

W91-01504

#### BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 1. EXPERIMENTAL INVESTIGATION.

Princeton Univ., NJ. Dept. of Computer Science.  
For primary bibliographic entry see Field 2F. W91-01531

#### BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 2. PERMEABILITY.

Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.  
For primary bibliographic entry see Field 2F. W91-01532

#### BIOFILM GROWTH AND THE RELATED CHANGES IN THE PHYSICAL PROPERTIES OF A POROUS MEDIUM. 3. DISPERSIVITY AND MODEL VERIFICATION.

Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.  
For primary bibliographic entry see Field 2F. W91-01533

#### SUBSTRATE AND BIOMASS TRANSPORT IN A POROUS MEDIUM.

State Univ. of New York at Buffalo. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 2F. W91-01534

#### SEASONAL VARIATION OF THERMOPHILIC CAMPYLOBACTERS IN SEWAGE SLUDGE.

Lancaster Univ. (England). Dept. of Biological Sciences.  
For primary bibliographic entry see Field 5B. W91-01655

#### PREVIEW ANALYSIS OF NATIONAL SLUDGE SURVEY.

Residuals Management Technology, Inc., Madison, WI.  
R. D. Kuchenrither, and S. I. McMillan.  
Biocycle BCYCDK, Vol. 31, No. 7, p 60-62, July 1990. 5 tab.

**Descriptors:** \*Data interpretation, \*Regulations, \*Sludge analysis, \*Wastewater facilities, Cadmium, Chemical analysis, Copper, Detection analysis, Environmental Protection Agency, Fate of pollutants, Heavy metals, Lead, Metals, Surveys, Zinc.

The National Sewage Sludge Survey conducted by the Environmental Protection Agency will be used to develop the agency's sludge regulations. A summary of the survey background and the preliminary results was reported. The survey randomly selected 209 wastewater treatment plants from all regions in the United States. The data, as compared to an earlier 40 city study, showed that most metals have been significantly reduced, except copper and zinc. A national average sludge, which indicates a mean concentration for metals and regulated organic compounds, was analyzed under the draft sludge regulations. Cadmium showed a surprisingly high concentration, but copper, lead and zinc were found at expected levels. Organics were essentially not detected in the survey due to high detection limits. The data should prove useful in developing future regulations, however, the high organic detection limit used for this survey may limit its effectiveness. (Miller-PTT)

W91-01661

#### COMPOST ODOR CONTROL THROUGH PROCESS OPTIMIZATION.

Claremont City Water/Sewer Div., NH.  
For primary bibliographic entry see Field 5D. W91-01662

#### PROPOSED EPA SLUDGE DISPOSAL REGULATIONS: PROJECT PURGATORY.

BCM Engineers, Inc., Plymouth Meeting, PA.  
D. D. Garvey.  
Water Pollution Control Association of Pennsylvania Magazine, Vol. 23, No. 4, p 13-21, July/August 1990. 6 fig, 4 tab.

## Ultimate Disposal Of Wastes—Group 5E

Descriptors: \*Economic aspects, \*Legal aspects, \*Pennsylvania, \*Regulations, \*Sludge disposal, Environmental Protection Agency, Heavy metals, Land reclamation, Metals, Risk assessment, Standards.

The EPA regulations Standards for the Disposal of Sewage Sludge are described with emphasis on the aspects that impact Pennsylvania. The initial estimate of the economic impact was that 157 million dollars per year nationwide would be needed to comply with these regulations. This figure was believed to be a gross underestimate. Metals and organics that were not previously a concern, such as arsenic, molybdenum, selenium, and beryllium would now be limiting factors, Congress mandated EPA to adopt a risk assessment approach to developing methodologies and disposal standards, some of which are not cost effective, implementable, or technologically achievable. The proposed regulations could have a significant impact on sludge disposal methods such as distribution and marketing, agricultural use and reclamation. (Miller-PTT) W91-01676

#### USE OF LIME-STABILIZED DAIRY-PLANT WASTE FOR FORAGE PRODUCTION.

Missouri Univ.-Columbia. Dept. of Agronomy. J. R. Brown, W. A. Bough, and C. Hoenshell. Journal of Production Agriculture, Vol. 3, No. 3, p 340-344, July/September 1990. 11 tab, 12 ref. USDA-CSRS Special Grant No. 85-CSRS-2-2548.

Descriptors: \*Lime, \*Sludge disposal, \*Soil amendments, \*Waste disposal, Dairy industry, Fescues, Forages, Grasses, Loam, Nitrogen, Phosphorus, Potassium, Silt.

A lime stabilizing sludge (LSS) from a dairy wastewater treatment plant was evaluated in field studies on a silt loam soil as a source of lime and P for a tall fescue (*Festuca arundinacea* Shreb.) meadow. An initial treatment of almost 9000 gal/acre significantly increased hay yields and raised the surface soil (0-3 in) above the pH and Bray and Kurtz no. 1 P sufficiency levels for tall fescue. Supplemental N and K were required to achieve maximum yields of the fescue treated with the lime stabilized biomass. There are in sufficient reserve lime in the LSS to offset the acidifying effects of 4 years of NH<sub>4</sub>NO<sub>3</sub> top-dressing. (Author's abstract) W91-01704

#### GROWTH AND VALUE OF CHLORELLA SALINA GROWN ON HIGHLY SALINE SEWAGE EFFLUENT.

Chinese Univ. of Hong Kong, Shatin. Dept. of Biology. For primary bibliographic entry see Field 5D. W91-01708

#### CONVERSION OF FAT INTO YEAST BIOMASS IN PROTEIN-CONTAINING WASTE-WATER.

Lund Univ. (Sweden). Dept. of Applied Microbiology. For primary bibliographic entry see Field 5D. W91-01717

#### POLYNUCLEAR AROMATIC HYDROCARBON (PAH) CONTENT OF ARCHIVED SEWAGE SLUDGES.

Lancaster Univ. (England). Inst. of Environmental and Biological Sciences. For primary bibliographic entry see Field 5A. W91-01737

#### LABORATORY STUDIES OF THE FLOW OF SOME ORGANIC SOLVENTS AND THEIR AQUEOUS SOLUTIONS THROUGH BENTONITE AND KAOLIN CLAYS.

General Motors Research Labs., Warren, MI. Environmental Science Dept. For primary bibliographic entry see Field 5B. W91-01781

#### HILLSLOPE EROSION AT THE MAXEY FLATS RADIOACTIVE WASTE DISPOSAL SITE, NORTHEASTERN KENTUCKY.

Geological Survey, Louisville, KY. Water Resources Div. For primary bibliographic entry see Field 2J. W91-01831

#### SOURCES AND DISTRIBUTION OF NITRATE IN GROUND WATER AT A FARMED FIELD IRRIGATED WITH SEWAGE TREATMENT-PLANT EFFLUENT, TALLAHASSEE, FLORIDA.

Geological Survey, Tallahassee, FL. Water Resources Div. M. P. Berndt. Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4006, 1990. 33p, 23 fig, 8 tab, 31 ref. Project No. FL-459.

Descriptors: \*Florida, \*Spray irrigation, \*Tallahassee, \*Wastewater disposal, \*Water pollution sources, Nitrates, Surficial aquifer, Treated wastewater, Upper Floridan Aquifer.

The city of Tallahassee, Florida began applying sewage treatment-plant effluent to a sprayfield southeast of the city in 1980. Fertilizers containing inorganic nitrogen were also applied in conjunction with the operation of a commercial farm at this site. Analysis of groundwater in the surficial aquifer and the Upper Floridan aquifer have indicated that nitrate concentrations in some wells exceed the prescribed drinking water maximum contaminant level of 10 mg/L (nitrate as nitrogen). Nitrate concentrations greater than the maximum contaminant level were not detected in samples from monitoring wells outside the sprayfield boundary. Analyses of water from the unsaturated zone indicated that conversion of organic nitrogen and ammonia to nitrate was complete before the nitrogen-enriched water reached the water table. Groundwater samples from wells in the surficial and Upper Floridan aquifers less than 100 ft deep located inside sprayed areas had mean concentrations of nitrate much higher than samples from similar wells located outside sprayed areas at the southeast sprayfield. These shallow wells inside the sprayed areas were the only wells in which the maximum contaminant level for nitrate was exceeded. Analyses of the nitrogen isotope ratios in groundwater were used to determine whether the major source of nitrogen was treated sewage or fertilizers. The nitrogen isotope ratios in contaminated groundwater at the southeast sprayfield were compared to those at another sprayfield southwest of the city, where treated sewage was the sole source of nitrogen. Statistical analyses indicated a significant difference in the nitrogen isotope ratios at the two sites, indicating that both nitrogen sources are significant at the southeast sprayfield. (USGS) W91-01857

#### USE OF PUMP-OUT FACILITIES BY RECREATIONAL BOATERS IN MARYLAND.

Maryland Univ., College Park. Dept. of Agricultural and Resource Economics. I. E. Strand, and G. R. Gibson. Estuaries ESTUD, Vol. 13, No. 3, p 282-286, September 1990. 3 tab, 11 ref.

Descriptors: \*Boats, \*Maryland, \*Pumps, \*Wastewater facilities, \*Water pollution prevention, Marinas, Recreation.

The State of Maryland sponsored a survey of 500 Maryland boaters to determine their use of marina facilities to discharge sewage from portable toilets or holding tanks. Results of the survey are reported as well as an examination of some of the factors that contribute to the use of pump-out facilities. Under 10% of Maryland's marinas have facilities available to pump-out holding tanks or portable toilets. Less than 1 in 20 boaters has ever used such a facility. Using a discrete choice behavior model, it was found that boaters with portable toilets were more likely to use holding tanks, especially if the holding tanks were equipped with macerating devices. The price of using the pump-out facility

negatively influenced pump-out use. It was also found that vessels in transition were less likely to use marina facilities. The availability of a pump-out facility at a boater's marina increased the likelihood of pumping by two-fold. In Maryland, reduction of boat-generated pollution will likely require a policy of both extensive pump-out services and low costs for the services. (Author's abstract) W91-01904

#### SUCCESSION OF THE PLANKTON COMMUNITY DURING COASTAL RECLAMATION WITH THE SOLID WASTES.

Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan). M. Yamada, Y. Hanada, A. Miyazaki, A. Tsuruta, and Y. Yoshida.

Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 56, No. 5, p 729-734, May 1990. 5 fig, 6 ref.

Descriptors: \*Land reclamation, \*Landfills, \*Plankton, \*Succession, \*Waste disposal, \*Water pollution effects, Japan, Oxidation ponds, Population dynamics, Solid wastes, Water quality.

The plankton community was investigated in a coastal pond at Kitakyushu City, Northern Kyushu, Japan. This pond was on a landfill where various kinds of solid wastes, including soil from land sources, domestic wastes, and industrial wastes, had been dumped from 1980 to 1987. The cell density of phytoplankton in the pond increased gradually and red tides were observed beginning in 1983. The plankton community was dominated by several species of diatoms, dinoflagellates, Cryptophyceae, green algae, filamentous bacteria, ciliates, and rotifers. Some of these occurred continuously, others cyclically during certain periods. Near the end of reclamation, the phototrophic red sulfur bacterium *Thiocapsa roseopersicina* predominated twice and discolored the water to purple-brown. The first time, phytoplankton almost disappeared from the pond but recovered after a few months; the second time, phytoplankton occurred abundantly with the phototrophic bacterium. In this pond, phytoplankton and zooplankton adapting to the water quality seem to have appeared one after another during most of this investigation. It is suggested that the large quantities of plankton which were observed are important in improving the water quality in the pond, and that the pond acts as an oxidation pond for polluted water from the solid wastes dumped. (Author's abstract) W91-01943

#### CHANGE OF WATER QUALITY AND COMPOSITION OF PLANKTON IN THE POND OF RECLAIMED SITE.

Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan). M. Yamada, Y. Hanada, S. Sueta, A. Tsuruta, and Y. Yoshida.

Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 56, No. 5, p 735-741, May 1990. 4 fig, 2 tab, 13 ref.

Descriptors: \*Land reclamation, \*Plankton, \*Population dynamics, \*Waste disposal, \*Water pollution effects, \*Water quality trends, Japan, Ponds, Solid wastes, Species composition, Succession.

Changes of plankton populations in relation to changes in water quality were investigated in a coastal pond on reclaimed land at Kitakyushu City, Japan. This site had been used for the disposal of various solid wastes. The pond water became rapidly brackish and polluted during the seven years required for the completion of the reclamation. Agglomerative cluster analysis was used to arrange the water quality in this pond in five clusters. Four water factors—pH, chlorinity, suspended solids, and COD—and four seasons—winter (February), spring (May), summer (August), and autumn (November)—were employed. The occurrence of dominant phytoplankton and the five clusters of water quality were compared; it was found that the change from marine plankton to brackish-water plankton was observed around 10 ppt in chlorinity, and freshwater plankton began to appear below 5

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5E—Ultimate Disposal Of Wastes

ppt in chlorinity. The marine plankton's highest COD value was 17 mg/L, but freshwater and brackish-water forms were able to occur at CODs as high as 40 mg/L. One species of phototrophic bacterium was observed in one abnormal cluster which had a COD of 160 mg/L and a pH of 11.2. There was thus an intimate relation between the occurrence of characteristic plankton and the water quality in each of the five clusters. The occurrence of planktonic biota and the variation of water quality were also affected by the climatic conditions, such as increased temperature and heavy rainfall. (Author's abstract)  
W91-01944

**MUTAGENS, TOXICANTS, AND OTHER CONSTITUENTS IN SMALL CITY SLUDGES IN NEW YORK STATE.**  
Pennsylvania State Univ., University Park. Pesticide Research Lab.  
For primary bibliographic entry see Field 5A.  
W91-01974

**CHARACTERIZATION OF DESALTING CONCENTRATES.**  
Rostek Services, Inc., Fort Myers, FL.  
For primary bibliographic entry see Field 3A.  
W91-01976

**HISTORIC DEVELOPMENT OF THE CONCENTRATE REGULATIONS.**  
Stone and Webster Engineering Corp., Fort Lauderdale, FL.  
For primary bibliographic entry see Field 5G.  
W91-01977

**CURRENT REGULATORY CONCERNS RELATED TO THE DISPOSAL OF RO CONCENTRATES IN FLORIDA.**  
Florida State Dept. of Environmental Regulation, Tallahassee.  
For primary bibliographic entry see Field 5G.  
W91-01978

**SURFACE WATER DISCHARGE OF REVERSE OSMOSIS CONCENTRATES.**  
Post, Buckley, Schuh and Jernigan, Inc., Orlando, FL.  
P. J. Malaxos, and O. J. Morin.  
Desalination DSLNAH, Vol. 78, No. 1, p 27-40, July 1990. 2 fig, 12 tab, 5 ref.

Descriptors: \*Desalination wastes, \*Florida, \*Potable water, \*Reverse osmosis, \*Surface water, \*Wastewater disposal, Desalination, Economic aspects, Membrane processes, Permits, Radioactive wastes, Testing procedures.

On the most recent list available from the Florida Department of Environmental Regulation (FDER), there are 96 membrane plants in Florida treating water for potable consumption. From the cursory studies and surveys conducted to date, some concern has been generated regarding dissolved oxygen, gross alpha radioactivity, fluorides and sulfides normally present in reverse osmosis (RO) concentrates. None of these were produced by RO process itself and it would appear that post-treatment methods can be developed to eliminate any adverse effect on the environment. However, compliance with the radioactivity standards is a difficult problem that is not easily resolved. There is a wide disparity in post-treatment methods being carried out at each facility. This is most probably due to the differences in permitting requirements (i.e., some plants are given potable water permits, some are given industrial waste permits). Finally, there are apparent differences in the types of testing and reporting being carried out. Case histories and economic considerations are also given. (Author's abstract)  
W91-01979

**DISPOSAL OF CONCENTRATE FROM BRACKISH WATER DESALTING PLANTS BY USE OF DEEP INJECTION WELLS.**  
A. Muniz, and S. T. Skehan.

Desalination DSLNAH, Vol. 78, No. 1, p 41-47, July 1990. 1 fig.

Descriptors: \*Brackish water, \*Desalination wastes, \*Florida, \*Injection wells, \*Reverse osmosis, \*Wastewater disposal, Desalination, Design standards, Membrane processes, Monitoring wells, Regulations, Wastewater treatment.

The conventional method of disposal of the concentrate from reverse osmosis plants in Florida has been discharge to a brackish surface water body. In Florida, however, the distance to saline water bodies and regulatory constraints can resist this type of disposal. Under the appropriate site-specific conditions, deep injection wells can offer a feasible solution to disposing of concentrates from reverse osmosis plants. Deep injection well systems can be reliable, environmentally safe, and cost-effective. Regulations affecting deep injection wells and typical designs are discussed. The Englewood (Florida) Water District deep injection well is described in detail. Instrumentation for this injection well disposal system includes continuous flow and pressure recorders plus sampling of the monitor well on a weekly, monthly, and quarterly basis. There has been considerable experience with deep injection wells for the disposal of treated wastewater effluents in the state, so that deep injection wells are a proven technology for South Florida. (VerNooy-PTT)  
W91-01980

**IRRIGATION WITH MEMBRANE PLANT CONCENTRATE: FORT MYERS CASE STUDY.**  
Boyle Engineering Corp., Fort Myers, FL.  
For primary bibliographic entry see Field 3C.  
W91-01981

**USE OF SOLAR PONDS IN THE DISPOSAL OF DESALTING CONCENTRATE.**  
California State Dept. of Water Resources, Fresno. Special Investigations Branch.  
B. E. Smith.  
Desalination DSLNAH, Vol. 78, No. 1, p 59-70, July 1990. 11 fig, 1 tab.

Descriptors: \*Agricultural water, \*Brines, \*California, \*Desalination wastes, \*San Joaquin Valley, \*Solar ponds, \*Thermal powerplants, \*Waste disposal, \*Wastewater renovation, Desalination, Drainage water, Evaporation ponds, Feasibility studies, Reverse osmosis, Saline water, Salinity, Subsurface drainage, Valleys, Wastewater disposal.

A major problem in California's San Joaquin Valley is the disposal of subsurface agricultural drainage water. The valley is 260 miles long and does not have an acceptable drainage water outlet to the ocean. The feasibility of storing and disposing drainage water desalting plant concentrates in a salt-gradient solar pond was investigated as part of a larger feasibility study on reclaiming agricultural drainage water for beneficial use. As part of the desalting feasibility investigation salt-gradient solar ponds for brine storage are being studied. It is method of storing and using concentrated desalting concentrates to produce power. The Los Banos Demonstration Desalting Facility was constructed to test the feasibility of reclaiming the drainage water. The facility is of the zero-discharge type, minimizing environmental impacts, and uses a three stage reverse osmosis system with thermal evaporation to achieve a 96% recovery of fresh water. Research in the Las Banos system is at the energy production stage and is focused on using a Rankine-cycle turbine for power generation using hot brine from the solar pond system. The cost of a solar pond facility is close to that of a Class I hazardous waste disposal site at from \$50,000 (no pond linings) to \$250,000 (double linings) per acre. The Solar pond concept shows a great deal of promise for helping manage agricultural drainage in California's San Joaquin Valley. (VerNooy-PTT)  
W91-01982

**DISPOSAL OF CONCENTRATES FROM BRACKISH WATER DESALTING PLANTS BY MEANS OF EVAPORATION TECHNOLOGY.**

Bechtel National, Inc., Washington, DC.  
L. Awerbuch, and M. C. Weekes.

Desalination DSLNAH, Vol. 78, No. 1, p 71-76, July 1990. 2 fig, 4 ref.

Descriptors: \*Brackish water, \*Brines, \*Desalination wastes, \*Evaporators, \*Reverse osmosis, \*Waste disposal, \*Wastewater disposal, Desalination, Feedwater treatment, Scaling.

Reverse osmosis plants discharge a permeate stream with low dissolved solids (TDS) and a reject stream with high TDS. The use of reverse osmosis (RO) plants to desalt brackish water in South Florida has increased rapidly in the last decade. The concentration of scale forming species such as calcium sulfate and silica usually limits RO recovery in these plants to about 75% of the total feedwater flow. The remaining 25% of the flow is reject brine which presents a serious disposal problem for plants in inland locations. Brine concentrators are being used to reduce the RO reject brine to 2% of the overall flow and so significantly reduce the disposal problem. Two versions of the evaporative brine concentration process known as vapor compression evaporation (VCE) are discussed. Typical operating conditions obtained at successfully operating plants are listed, and projected hybrid plant performance is calculated. Small size VCE system may be installed for \$7.50/gal/day. As the sizes increase, the installed price may drop to \$6.00/gal/day. (Author's abstract)  
W91-01983

#### HIGH RECOVERY REVERSE OSMOSIS.

Stone and Webster Engineering Corp., Fort Lauderdale, FL.  
For primary bibliographic entry see Field 3A.  
W91-01985

**CHARACTERIZATION OF COMPOST WITH RESPECT TO ITS CONTENT OF HEAVY METALS, PART I: SAMPLE DIGESTION AND ICP-AES ANALYSIS.**  
Amsterdam Univ. (Netherlands). Vakgroep Milieukunde.

J. W. A. Lustenhouwer, J. A. Hin, F. J. M. J. Maessen, and G. den Boef.  
International Journal of Environmental Analytical Chemistry IJEA3, Vol. 39, No. 3, p 209-222, 1990. 3 fig, 11 tab, 18 ref.

Descriptors: \*Analytical techniques, \*Chemical analysis, \*Compost, \*Emission spectroscopy, \*Heavy metals, \*Sample preparation, \*Sludge disposal, Composting, Digestion, Domestic wastes, Elements, Monitoring, Soil amendments, Testing procedures, The Netherlands, Waste identification.

In recent years the Dutch policy on management of household waste has been increasingly directed towards recycling. Composting might be a solution for about one half of household waste; however, there is a growing concern on the quality of compost, especially with regard to its content of heavy metals. A study was conducted to develop a procedure for the determination of heavy metals in compost. An unambiguous analytical procedure must be available to enable supervision of the legal regulations on maximum tolerable content of heavy metals. The element determination stage, including the digestion of a test portion and element determination in the test solution, is reported. Analysis was studied for a variety of types of composts as well as for a sewage sludge amended soil. Aqua regia digestion was examined using conventional as well as microwave heating. The performance of both procedures is similar with respect to accuracy and precision. Microwave heating was preferred because that procedure is less time-consuming. Simultaneous determination of the elements chromium, copper, nickel, lead, and zinc by inductively coupled plasma-atomic emission spectroscopy was feasible. However, due to the occurrence of severe spectral interferences, cadmium had to be determined separately. (VerNooy-PTT)  
W91-01986

## Water Treatment and Quality Alteration—Group 5F

**EFFECT OF PULP AND PAPER MILL EFFLUENT IRRIGATION ON CARBON DIOXIDE EVOLUTION IN SOILS.**

Tamil Nadu Agricultural Univ., Coimbatore (India). Dept. of Agricultural Microbiology. K. Kannan, and G. Obilismi.  
Journal of Agronomy and Crop Science ZAPFAR, Vol. 164, No. 2, p 116-119, 1990. 1 fig, 2 tab, 13 ref.

Descriptors: \*Carbon dioxide, \*Effluents, \*Industrial wastewater, \*Pulp and paper industry, \*Soil gases, \*Wastewater irrigation, Conductivity, Decomposing organic matter, Field tests, India, Microorganisms, Soil bacteria, Soil contamination, Soil organic matter, Wastewater farming.

Soil samples were collected from the field under paper mill effluent irrigation for the past 1, 2, 3, and 15 years. Pulp and paper mill wastewater irrigation increased pH, electrical conductivity (EC), organic carbon, and exchangeable sodium content of soils. The combined effluent irrigation over a period of 15 years resulted in the increased accumulation of sodium and other soluble salts. Soils under effluent irrigation for the past 15 years showed the maximum EC which might be due to accumulation of salts over a long period of time. The increase in organic matter content of soils accelerated microbial activity and hence accelerated substrate decomposition with the release of carbon dioxide. There was a peak followed by a steady decline in the rate of carbon dioxide evolution in effluent irrigated soils. The total amount of carbon dioxide evolved in the control was 5.039 mg/50 g soil (dry weight basis over 15 days), while combined effluent irrigation over a period of 15 years increased the carbon dioxide evolution rate by a factor of five. The carbon dioxide evolution results of the present investigation suggest that pulp and paper mill effluent irrigation to soil was not harmful to the soil microbial activity. (Ver-Neoy-PTT)  
W91-01987

**5F. Water Treatment and Quality Alteration****TREATMENT OF EUTROPHIC WATERS IN SOUTH AFRICA.**

Water Research Commission, Pretoria (South Africa).  
G. Offringa.

South African Journal of Science SAJSAR, Vol. 86, No. 1, p 6-8, January 1990. 2 fig, 8 ref.

Descriptors: \*Eutrophic lakes, \*South Africa, \*Water quality, \*Water treatment, Chlorination, Filtration, Flocculation, Potable water, Settling, Surface water, Water quality control.

Eutrophication of surface waters has caused increased concern in South Africa and elsewhere regarding the supply of potable water of good quality from these sources. Sedimentation and filtration alone are not adequate to treat enriched waters anymore. Pre-chlorination improves the sedimentation of flocculated algae but results in taste and odor problems and the excessive formation of halogenated hydrocarbons. The Division of Water Technology of CSIR has developed considerable expertise in the application of Dissolved Air Flotation (DAF) alone, and in combination with filtration (DAFF), resulting in the construction of a number of plants for the treatment of a variety of enriched waters. Whereas the traditional water treatment by sedimentation relied on the settlement of solids in the water, the lighter nature of algae and other suspended organics found in eutrophic waters rendered the DAF process more suitable for solids removal and so it is increasingly being used in South Africa and abroad. The need to incorporate the sedimentation into the DAFF process to treat surface waters of variable quality, and to remove tastes, odors and other micropollutants has been identified, and further research has been directed accordingly. (Lantz-PTT)  
W91-01074

**HYDROGEOLOGY AND HISTORICAL ASSESSMENT OF A CLASSIC SEQUENTIAL-LAND USE LANDFILL SITE, ILLINOIS, USA.**

Northern Illinois Univ., De Kalb. Dept. of Geology. C. J. Booth, and P. J. Vagt.  
Environmental Geology and Water Sciences EGWSEI, Vol. 15, No. 3, p 165-178, May/June 1990. 6 fig, 5 tab, 19 ref, 3 append.

Descriptors: \*Geohydrology, \*Groundwater pollution, \*Illinois, \*Landfills, \*Path of pollutants, \*Water pollution sources, Clay liners, Contamination, Groundwater quality, History, Land use, Leachates, Resource management.

The Blackwell site in northeastern Illinois was a classic sequential-use project combining land reclamation, a sanitary landfill, and a recreational park. A recent assessment of leachate generation and groundwater contamination to the site's unfinished record is presented. Hydrogeological studies show that: (1) the landfill sits astride an outwash aquifer and a till mound, which are separated from an underlying dolomite aquifer by a thin, silty till; (2) leachate leaks from the landfill at an estimated average rate between 48 and 78 cubic m/day; (3) the resultant contaminant plume is virtually stagnant in the till but rapidly diluted in the outwash aquifer, so that no off-site contamination is detected; and (4) trace volatile organic carbon VOC levels in the dolomite probably indicate that contaminants have migrated there from the landfill-derived plume in the outwash. Deviations from the original landfill concepts included elimination of a leachate collection system, increased landfill size, local absence of a clay liner, and partial use of nonclay cover. The hydrogeological setting was unsuitable for the landfill as constructed, indicating the importance of detailed geological consideration in landfill and land-use planning. (Author's abstract)  
W91-01097

**FIXED BED ADSORPTION FOR THE REMOVAL OF POLLUTANTS FROM WATER.**

Queen's Univ., Belfast (Northern Ireland). Dept. of Chemical Engineering. G. McKay, and M. J. Bino.  
Environmental Pollution ENPOEK, Vol. 66, No. 1, p 33-53, 1990. 17 fig, 4 tab, 7 ref.

Descriptors: \*Activated carbon, \*Adsorption, \*Mercury, \*Phenols, \*Water treatment, Chlorophenols, Design criteria, Fixed bed columns, Flow rates, Operating costs.

The adsorption of phenol, p-chlorophenol and mercuric ions from aqueous solution onto activated carbon has been studied in fixed bed columns. The influence of varying parameters such as bed depth, solution flowrate and pollutant concentration has been studied. The Bed Depth Service Time (BDST), using the break point of the effluent concentration, has been used to analyze the experimental data and identify design correlations. The BDST model can predict service time versus bed depth according to the desired percentage breakthrough value. The breakthrough curve represents the shape of the pollutant concentration curve as the solution leaves the bed. The general observation is that no significant increase in throughput is achieved by varying the percentage breakthrough because the breakthrough curves are rather steep and, consequently, the mass transfer zone is very short. Two types of variables are recognized as important in optimizing water treatment processes: primary process variables which are mainly determined by carbon exhaustion rates; and process variables which affect the operating costs as a result of changes in the required level of effluent purity, influent liquid purity, temperature, and viscosity, as well as carbon particle size. Optimization procedures based on the Empty Bed Residence Time have been applied to the data, showing that the carbon exhaustion rate is higher for lower percentage breakthrough required. (Brunone-PTT)  
W91-01110

**REVIEW OF OZONE GENERATING FACILITIES IN SOME U.S. WATER AND WASTEWATER TREATMENT PLANTS.**

Northeast Ohio Regional Sewer District, Cleveland, OH.  
L. Debevec.

Ozone: Science and Engineering OZSEDS, Vol. 12, No. 2, p 95-105, 1990. 13 tab, 6 ref.

Descriptors: \*Ozonation, \*Wastewater facilities, \*Water treatment facilities, Feedwater treatment, Municipal wastewater, Municipal water, Ozone, Water quality management.

In previous years, the start-up and operation of ozone systems at U.S. municipal water and wastewater treatment plants has resulted in numerous problems. Some of these problems were of such a magnitude that the operating agency decided to abandon the ozone system. In other cases the systems are operating with the problems resolved. Many of the problems were not unique to any one system. A summary includes the following responses: (1) at least three installations had problems with fires in the ozone destructor; (2) five of the installations experienced problems with the discharge valves; (3) foaming problems are prevalent in almost every contractor; (4) six of the installations use oxygen to generate ozone, four of the installations use air, only one uses both air or a mixture of air and oxygen; (5) of the 11 plants, 9 installations have blowers to remove the ozone contractor off-gas, one installation used the system pressure to force the off-gas through the ozone destructor, while the last facility did not know how the off-gas was removed from the contractor; and (6) of the 5 air-to-ozone generation installations, 4 were a gas-to-gas (freon) refrigeration system, and the other uses a liquid-to-gas (freon) system. (King-PTT)  
W91-01165

**EVALUATION OF EMPIRICAL PROCESS DESIGN RELATIONSHIPS FOR OZONE DISINFECTION OF WATER AND WASTEWATER.**

Alberta Univ., Edmonton. Dept. of Civil Engineering.

For primary bibliographic entry see Field 5D.

W91-01167

**REMOVAL OF ATRAZINE BY OZONE AND OZONE-HYDROGEN PEROXIDE COMBINATIONS IN SURFACE WATER.**

Laboratoire Central de la Lyonnaise des Eaux 38, rue de la President Wilson, 78230 le Pecq, France. J. P. Duguet, F. Bernazeau, and J. Mailleville.  
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 2, p 195-197, 1990. 2 tab, 4 ref.

Descriptors: \*Atrazine, \*Hydrogen peroxide, \*Ozonation, \*Ozone, \*Water treatment, Adsorption, Filtration, Maximum contaminant level, Pesticides, Water quality.

Atrazine is one of the most frequently identified pesticides in Europe. Current European standards stipulate that the maximum contaminant level (MCL) for an individual pesticide is 100 ng/L. This regulation stresses the need for a low-cost and effective treatment system. Adsorption is one promising solution, but in general, breakthrough of the granular activated carbon filter occurs rapidly. Recent research has shown that ozonation alone, utilized according to the usual practical conditions, removes atrazine poorly, 15-25%. High oxidation reaction rates of the hydroxyl free radical suggest that combinations of O<sub>3</sub>/H<sub>2</sub>O<sub>2</sub> is a better removal method. This study indicates that application of an ozone dose of 5.1 mg/L without hydrogen peroxide allows a 46% reduction in atrazine concentration, but the MCL was not reached. The coupling of ozone and hydrogen peroxide increases the removal of atrazine. The removal efficiency increases as the applied oxidant dose increases. It is therefore possible to reach the atrazine MCL by applying in this case, a 3 mg/l dose. (Author's abstract)  
W91-01168

**OZONATION AT BELLE GLADE, FLORIDA: A CASE HISTORY.**

North Carolina Univ. at Charlotte. Dept. of Envi-

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5F—Water Treatment and Quality Alteration

ronmental Sciences and Engineering.  
P. C. Singer, K. Robinson, and R. A. Elefritz.  
Ozone: Science and Engineering OZSEDS, Vol. 12, No. 2, p 199-215, 1990. 11 fig, 4 tab, 4 ref.

Descriptors: \*Color removal, \*Ozonation, \*Water treatment, Ammonia, Belle Glade, \*Florida, Chlorine, Chloroform, Color, Florida, Nitrification, Organic matter, Ozone, Trihalomethanes, Turbidity, Water quality control.

A two-stage ozonation process for the treatment of lake water high in organics, color and trihalomethanes (THM) concentration was installed at the city of Belle Glade, FL in October of 1984. The average TOC was 30 mg/l with values of up to 755 mg/L. The color averaged 100 color units up to 500 color units. The THM level reached nearly 1,000 mg/L. The new treatment process applied 3 mg/l of ozone to the raw water ahead of the flash mix basin, lime softening, alum and polymer coagulation, clarification, recarbonation, and addition of 3 mg/l ozone prior to filtration. Post-chlorination then produced distribution system THM concentrations averaging 124 microgm/L. Distribution of THM's shifted from 85% chloroform by the original process to 40% after adoption of ozonation, the balance comprising brominated species, but not bromoform. In 1987, the treatment process was modified by adding chlorine and ammonia at the outlets of the pre-, and intermediate stages of ozonation and abandoning free chlorination. This has further reduced the distribution system THM levels to 20-30 microgm/L. Filtered water turbidity and color have been improved. The use of chloramines after ozonation controls the nuisance aquatic growth in the clarifiers and recarbonation basins, produces a combined chlorine residual which can be maintained throughout the distribution system. Periodic use of free chlorine in the distribution system is required to prevent elevated heterotrophic plate counts and the formation of excessive concentrations of nitrite ion due to biological regrowth and nitrification. (Author's abstract)

W91-01169

#### ULTRAVIOLET DISINFECTION OF POTABLE WATER.

Southern California Metropolitan Water District, Los Angeles.  
R. L. Wolfe.  
Environmental Science and Technology ESTHAG, Vol. 24, No. 6, p 768-772, June 1990. 1 fig, 3 tab, 38 ref.

Descriptors: \*Disinfection, \*Drinking water, \*Potable water, \*Ultraviolet radiation, \*Water treatment, Bacteria, Groundwater, Protozoa, Surface water, Viruses.

Pending regulations by the Environmental Protection Agency regarding control of microbial and chemical contaminants in drinking water has prompted the evaluation of ultraviolet (UV) radiation for primary disinfection of surface and groundwater supplies. Excellent results for inactivation of both bacteria and viruses have been obtained with the combined advantages of short contact times, low relative cost, few undesirable disinfection by-products, and enhanced breakdown of taste and odor contaminants. The drawbacks include inaccuracy of current systems for UV dose measurement, limitations on practical size of cost-effective treatment plants, the necessity of postdisinfection for surface waters, and the requirement of much higher UV doses for the inactivation of protozoan cysts. To date only a limited number of microorganisms have been examined and no actual field information has been obtained. In addition, complete information on the resistance of enteric viruses is not yet available. (D'Agostino-PTT)

W91-01179

#### RECOVERY OF 3-CHLORO-4-DICHLORO-METHYL-5-HYDROXY-2(5H)-FURANONE FROM WATER SAMPLES ON XAD RESINS AND THE EFFECT OF CHLORINE ON ITS MUTAGENICITY.

Health Effects Research Lab., Research Triangle Park, NC. Genetic Toxicology Div.

For primary bibliographic entry see Field 5A.  
W91-01181

#### CONTAMINATION OF POTABLE WATER BY CORROSION OF TIN-LEAD SOLDERED JOINTS.

Surrey Univ., Guildford (England). Dept. of Materials Science and Engineering.  
For primary bibliographic entry see Field 5B.  
W91-01222

#### INTERFACE OF HEALTH EFFECTS AND CHEMISTRY AT WATER TREATMENT PLANTS.

Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).  
L. Cognet, J. P. Duguet, and J. Mallevialle.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 255-264, 4 fig, 22 ref.

Descriptors: \*Chlorination, \*Disinfection, \*Drinking water, \*Mutagenicity, \*Public health, \*Water quality, \*Water treatment, Activated carbon, Chlorine, Filtration, Organic matter, Oxidation, Ozonation, Raw water.

Data on raw water quality, oxidation treatment practices, and the resulting mutagenic properties of the treated water were compiled from pilot- and full-scale treatment experiments to evaluate which parameter might produce variability in the results of a mutagenic study. Analysis of the data and comparison of treatment practices indicated that the measured mutagenic activity is strongly related to the characteristics of the organic matrix in the raw water; the methodology used to sample and detect mutagens; the scale of the study both in terms of treatment flow and period of study; and the point at which and the conditions under which oxidants are added during treatment. In disinfection systems in full-scale water treatment plants, when raw water is pretreated, and high concentrations of organics are present in the raw water, both ozonation and chlorination increase mutagenic activity. However, no significant difference in mutagenicity was found between the two oxidants. Also, both in the case of a nitrified groundwater and a clarified surface water, the mutagenic activity of the water after ozonation was related to its mutagenic activity before ozonation. Also, in both of these cases, mutagenic activity decreased after granular activated carbon (GAC) filtration. When GAC filtration follows ozone disinfection, early addition of oxidants may not be deleterious to the finished water quality. When chlorine or chlorine dioxide is added after GAC filtration, chlorine dioxide was found to produce a less mutagenic water. Although these conclusions suggest means of controlling mutagenic activity during treatment, it must be stressed that the measurement of mutagenicity is a presumptive index of contamination level. (See also W91-01211) (Author's abstract)

W91-01226

#### MICROPOLLUTANTS IN WATER USED FOR RENAL DIALYSIS: AN INTERNATIONAL PERSPECTIVE.

Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.  
For primary bibliographic entry see Field 5C.  
W91-01227

#### CLINICAL AND ENVIRONMENTAL EFFECTS OF A MAJOR EMERGENCY INVOLVING PUBLIC WATER SUPPLY.

Robens Inst. of Industrial and Environmental Health and Safety, Guildford (England). Trace Element Lab.  
For primary bibliographic entry see Field 5G.  
W91-01228

#### BIOFILMS: DETECTION, IMPLICATIONS AND SOLUTIONS.

Centre for Applied Microbiology Research, Salisbury (England).

C. W. Keevil, A. A. West, J. T. Walker, J. V. Lee, and P. J. L. Dennis.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 367-374, 37 ref.

Descriptors: \*Biofilms, \*Biofouling, \*Domestic water, \*Drinking water, \*Fouling, \*Plumbing, \*Public health, \*Water distribution, \*Water treatment, Aeromonas, Aromatic compounds, Biocides, Copper, Corrosion, Disinfection, Legionella, Path of pollutants, Pseudomonas, Scotland.

Water treated and supplied for drinking and domestic purposes is not sterile and biofilms are normally found on the materials used in distribution and plumbing systems. The growth of low numbers of microorganisms in the planktonic and sessile phases is usually considered only in terms of aesthetic or operational problems. However, biofilms have been linked to a unique corrosion of copper pipework in institutional buildings in Scotland and biofouling of recirculating water systems is believed to contribute to the proliferation of opportunistic pathogens such as *Pseudomonas aeruginosa*, *Aeromonas hydrophila* and *Legionella pneumophila*. These organisms are occasionally present in treated water and all have been identified in plumbing systems biofilms. While planktonic microorganisms are relatively easily killed by biocides, organisms in the biofilms are more refractory due to poor penetration rates. A continuous culture laboratory model has been developed to investigate the factors responsible for biofilm formation on the surfaces of plumbing materials. It has already proved valuable to assess the implications and design solutions to control copper corrosion and legionellae colonization. The same approach is now being used to address issues related to potable supplies such as nitrite formation, residual disinfection, degradation of coal tar linings releasing polycyclic aromatic hydrocarbons and the control of indicator organisms. (See also W91-01211) (Author's abstract)

W91-01239

#### ADVANCED NITROGEN REMOVAL PROCESSES FOR DRINKING AND WASTE WATER TREATMENT.

Biwater Ltd., Heywood (England).  
For primary bibliographic entry see Field 5D.  
W91-01247

#### CONTROL OF NITROGENOUS POLLUTION.

Surrey Univ., Guildford (England). Dept. of Chemical Engineering.

For primary bibliographic entry see Field 5D.

W91-01250

#### WATER TREATMENT TECHNOLOGY FOR REMOVING PESTICIDES FROM WATER.

Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).  
A. Bruchet, J. P. Duguet, J. Mallevialle, and F. Fiessinger.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 487-496, 7 fig, 5 tab, 24 ref.

Descriptors: \*Coagulation, \*Flocculation, \*Ozonation, \*Pesticides, \*Water treatment, Activated carbon, Chlorination, Chlorine, Drinking water, Fungicides, Groundwater pollution, Herbicides, Insecticides.

The effectiveness of various procedures or coupled procedures used in treatment works to eliminate pesticides from drinking water are examined. At the mg/L concentration level using surface water enriched in pesticides of different chemical origins, laboratory coagulation-flocculation tests using iron and aluminum salts revealed that, of all the pesticides, only methoxychlor and DDT are more than 90% eliminated. For concentrations ranging from the nanogram/L level to 100 micrograms/L, in the

laboratory or at pilot level, DDT was eliminated up to 98%. For lindane, aldrin, dieldrin, parathion, 2,4-D, and endosulfan, the degree of elimination varied between 10% and 60%. Coagulation-flocculation removal of pesticides was enhanced at optimal rates with various coagulants for different pesticides at different pH. Ozonation is extremely effective for the removal of triazine pesticides. When activated charcoal is used for pesticide removal the dose of powder added must be in accord with the level of pesticide to be removed requiring continual monitoring of pesticide levels. Filtering through activated charcoal reduces the peak level of pesticides in treated water. However, it is difficult to predict the effectiveness of this peak-lowering and consequently to guarantee that the maximum acceptable concentration of 100 nanograms/L will not be exceeded. (See also W91-01211) (Geiger-PTT) W91-01252

#### REMOVAL OF PESTICIDES BY ADSORPTION ONTO POWDERED ACTIVATED CARBON: THE EFFECT OF HUMIC SUBSTANCES.

Limoges Univ. (France). Lab. de Genie Chimique, Traitement des Eaux.

J. Ayele, B. Fabre, and M. Mazet.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York, 1989. p 497-504, 5 fig, 3 tab, 24 ref.

Descriptors: \*Activated carbon, \*Adsorption, \*Humic substances, \*Pesticides, \*Water treatment, Atrazine, Fulvic acids, Humic acids, Hydrogen ion concentration, Insecticides, Lindane, Pentachlorophenol, Solubility.

Factors affecting the adsorption of lindane, atrazine, and pentachlorophenol (PCP) and humic substances onto activated carbon were examined. The concentrations of pesticides and humic substances (humic and fulvic acids) in solutions were measured before and after shaking in the presence of the activated carbon at 25°C by UV absorbance, high pressure liquid chromatography, or scintillation counting. Results showed that dependence of solubility on pH is strong for PCP but not very important for atrazine or lindane. PCP water solubility increased with increasing pH. Adsorption of PCP was decreased when solubility was increased. The extent of binding of pesticides increased as water solubility decreased, and depended on the source and concentration of the humic substances. Humic substances improved the removal efficiency of pesticides, while the presence of pesticides slightly enhanced the removal of the humic substances by activated carbon. Adsorption onto activated carbon was more rapid for PCP than for atrazine or lindane. The pesticide-humic substances complex was more easily adsorbed than pesticides or humic substances alone. (See also W91-01211) (Geiger-PTT) W91-01253

#### WATER QUALITY MANAGEMENT IN ISTANBUL: CREATING A CLEANER ENVIRONMENT.

Istanbul Water and Sewerage Administration, Turkey.

For primary bibliographic entry see Field 5G. W91-01254

#### ROLE OF ASSET MANAGEMENT.

Water Research Centre, Swindon (England). Asset Management.

For primary bibliographic entry see Field 6A. W91-01272

#### NEW TECHNOLOGY IN A WATER COMPANY.

South Staffordshire Waterworks Co., Walsall (England).

J. Carter.  
Journal of the Institution of Water and Environmental Management JIWMET, Vol. 4, No. 3, p 256-264, June 1990. 3 fig, 1 tab.

Descriptors: \*Automation, \*Data processing, \*Water conveyance, \*Water treatment, Chemical analysis, Computer-aided design, Computers, Data storage and retrieval, Excavation, Inspection, Leakage, Monitoring, Remote sensing, Technology, Telemetry, Water management.

The South Staffordshire Water Company serves a population of 1.25 million within an area of 1502 sq km, and has employed new technology across a broad spectrum of its operational, scientific and administrative activities. Applications of this technology include electronic remittance processing, a mail room multitrailer, a computerized customer service system, automation of chemical analysis, automatic fuel issue and recording equipment, computer-aided drawing (CAD) in the design office, telemetry and electronic leak detection, fiberoptic inspection methods, and location sensors for excavation. Available technologies have been investigated, adapted and developed to meet the Company's particular requirements for improved efficiency, new regulations and standards, and cost savings. The Company is a leading innovator in the use of new technology; this success has been achieved through the encouragement and development of new ideas and the careful control and monitoring of new projects. (VerNooy-PTT) W91-01273

#### TRIAZINE AND CHLOROACETAMIDE HERBICIDES IN SYDENHAM RIVER WATER AND MUNICIPAL DRINKING WATER, DRESDEN, ONTARIO, CANADA, 1981-1987.

Ontario Ministry of Agriculture and Food, Guelph. Agricultural Lab. Services Branch.  
For primary bibliographic entry see Field 5B. W91-01306

#### ALUMINUM IN DOMESTIC WATER: OVERLOAD MAY BE HAZARDOUS TO DIALYSIS PATIENTS.

Louisiana State Univ. Medical Center, Shreveport.  
For primary bibliographic entry see Field 5C. W91-01382

#### SURFACE IONIZATION OF POLYNUCLEAR SPECIES IN AL(III) HYDROLYSIS-I. TITRATION RESULTS.

Syracuse Univ., NY. Dept. of Civil and Environmental Engineering.  
R. D. Letterman, and S. R. Asolekar.  
Water Research WATRAG, Vol. 24, No. 8, p 931-939, August 1990. 14 fig, 2 tab, 29 ref. National Science Foundation grant no. CEE-8315971.

Descriptors: \*Aluminum, \*Chemical reactions, \*Coagulants, \*Hydrolysis, \*Ionization, \*Metals, \*Water chemistry, \*Water treatment, Aqueous solutions, Chemical interactions, Hydrogen ion concentration.

The formation of polynuclear hydrolysis products of aluminum(III) involves reactions with two consecutive stages, a relatively rapid reaction followed by a slow reaction in which the hydrolysis products undergo subtle changes in chemical and physical form. The rapid part of the hydrolysis reaction was examined because it is this part of the process that is most important in understanding the action of aluminum salt coagulants in engineered systems. Successive titrations with base and acid using one solution yielded evidence that the relatively sharp transition to higher OH/Al values at a pH of about 6 may be caused, in part, by the formation of a relatively stable dispersion of a polynuclear species with OH/Al in the range of 2.5  $\pm$  0.3. Surface or edge site deprotonation of this species can be used to explain the OH/Al versus pH curve above pH 6. Destabilization of a polynuclear species by charge reduction through surface site deprotonation may control the formation of the visible aluminum hydroxide precipitate at pH > 6.5. The species/precipitate with OH/Al > 2.5 dissolves very slowly with acid addition. Dissolution occurred at a pH (4.9) which was significantly lower than the pH at which the species was formed and lower than the pH at which it apparently had aggregated to form the precipitate. (See also W91-01414) (Mertz-PTT)

W91-01413

#### SURFACE IONIZATION OF POLYNUCLEAR SPECIES IN AL(III) HYDROLYSIS-II. A CONDITIONAL EQUILIBRIUM MODEL.

Syracuse Univ., NY. Dept. of Civil and Environmental Engineering.

R. D. Letterman, and S. R. Asolekar.  
Water Research WATRAG, Vol. 24, No. 8, p 941-948, August 1990. 8 fig, 2 tab, 15 ref. National Science Foundation grant no. CEE-8315971.

Descriptors: \*Aluminum, \*Chemical reactions, \*Coagulants, \*Hydrolysis, \*Metals, \*Model studies, \*Water chemistry, \*Water treatment, Aqueous solutions, Chemical interactions, Equilibrium models, Hydrogen ion concentration, Kinetics.

The inclusion of reactions for the titration of edge or surface sites on polynuclear Al species can be used to improve the ability of a conditional equilibrium model of Al hydrolysis to predict the molar ratio of metal bound hydroxide ion to total metal concentration as a function of pH. Base and acid titrations of aluminum salt solutions were modeled by including in the reaction scheme the titration of protons from ionizable surface (or edge) sites on polynuclear species and the charged precipitate. It was assumed that the OH/Al ratio of the polynuclear species consists of a structural part, the hydroxide ions that link the Al ions, and a more labile surface site titration part. The hydrolysis products included in the best-fit reaction scheme are two monomeric species, Al(OH)(2+) and Al(OH)4(-), and two polynuclear species Al14(OH)32(10+) and Al(p)(OH)q(3p-q)(+) where (q/p) = 2.7 (q/p is the molar ratio of the structural hydroxide ion to aluminum in the polynuclear species). The precipitate is assumed to consist of aggregates of the larger polynuclear species destabilized by surface site deprotonation. The fitted solubility product (pKsp) for acid titration was -9.8, suggesting a significant kinetic difference between precipitate formation and dissolution. (See also W91-01413) (Mertz-PTT) W91-01414

#### OXIDATION OF PHENOLS IN WATER BY HYDROGEN PEROXIDE ON ALUMINE SUPPORTED IRON (OXYDATION DES PHENOLS PAR LE PEROXYDE D'HYDROGENE EN MILIEU AQUEUX EN PRESENCE DE FER SUPPORTE SUR ALUMINE).

Poitiers Univ. (France). Lab. de Chimie de l'Eau et des Nuisances.

For primary bibliographic entry see Field 2K. W91-01418

#### GENESIS OF FREE HYDRAULIC JUMPS FOR BETTER MIXING.

Roorkee Univ. (India). Dept. of Civil Engineering.  
D. S. Bhargava, and C. S. P. Ojha.  
Water Research WATRAG, Vol. 24, No. 8, p 1003-1010, August 1990. 4 fig, 3 tab, 5 ref, append.

Descriptors: \*Hydraulic jump, \*Hydraulics, \*Mixing, \*Water treatment, Channels, Coagulants, Model studies.

Free hydraulic jumps are frequently used in water treatment for mixing processes. Additions of coagulant doses in such a jump would result in a very thorough mixing of the chemical and in efficient dispersion in the entire body of the water to be treated. Such a mode of mixing is most desirable in situations where there is a power shortage or the supply is unreliable, as is currently the case in India. Analysis of the hydraulic jumps was carried out to determine the factors that are responsible for a very thorough and efficient mixing and dispersion of the coagulants. A free hydraulic jump design (which is considered to provide greater energy loss and thus a better mixing in comparison to the submerged jump) was examined for various discharge rates in the 0.1 to 5 cubic m/second range maintaining the desired depth to width ratio in the downstream channel. The free hydraulic jump was created by regulating the flume gates in a rectangular flume of 0.3 m width, 0.5 m depth

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and 7 m length. Increased mixing length corresponds to a lower standard deviation, which is expected, because at longer distances mixing improves. When the chemical was injected at the corner of the channel, the mixing length was greater than when injected at a central channel site. The addition of chemicals on the upstream side of the jump results in an insignificant saving of the effective mixing length. The effective mixing distance is always more than the jump length. This means that the downstream length of the free hydraulic jump channel should be about the length of the free hydraulic jump. When the discharge decreases by a factor of three, the effective mixing distance decreases only 1.25 times. This ensures a shorter effective mixing distance at the minimum flow for a designed channel. (Mertz-PTT)  
W91-01421

**LITHIUM IN DRINKING WATER AND THE INCIDENCES OF CRIMES, SUICIDES, AND ARRESTS RELATED TO DRUG ADDICTIONS.** California Univ., San Diego, La Jolla. Dept. of Chemistry.

G. N. Schrauzer, and K. P. Shrestha. Biological Trace Element Research BTERDG, Vol. 25, No. 2, p 105-113, May 1990. 3 tab, 20 ref.

**Descriptors:** \*Behavior, \*Drinking water, \*Lithium, \*Public health, \*Trace elements, Biochemistry, Environmental effects, Water quality control, Water quality management, Water quality standards.

Lithium is a trace element that is widely used in the treatment of various mental disorders. Previous studies have compared the lithium concentrations in the regional drinking water supplies with the incidence of mental disorders and homicide rates in Texas and found a statistically significant inverse relationship. Since incidence data for only two years (1967-1969) were used in the studies, the relationships between drinking water lithium with homicide and suicide rates were reinvestigated for 10 years (1978-1987) and extended to other crimes, arrests for possession of opium, cocaine, and their derivatives, and possession of marijuana, as well as arrests for drunkenness (1981-1986). Using data for 27 Texas counties it was shown that the incidence rates of suicide, homicide, rape, robbery, burglary, and theft are significantly higher in counties whose drinking water supplies contain little or no lithium than in counties with water lithium levels ranging from 70-170 micrograms/L. These results suggest that lithium has moderating effects on suicidal and violent criminal behavior at levels that may be encountered in municipal water supplies. Comparisons of drinking water lithium levels with the incidences of arrests for possession of opium, cocaine, and their derivatives also produced statistically significant inverse associations, whereas no significant or consistent associations were observed with possession of marijuana and drunkenness. These results suggest that lithium at low dosage levels has a beneficial effect on human behavior. Lithiation of drinking water is suggested as a possible means of crime, suicide, and drug-dependency reduction at the individual and community level. (Author's abstract)  
W91-01483

#### MODEL FOR WATER DISTRIBUTION SYSTEM RELIABILITY.

Texas Univ. at Austin. Dept. of Civil Engineering. Y. Bao, and L. W. Mays.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 9, p 1119-1137, September 1990. 11 fig, 4 tab, 23 ref. National Science Foundation Project Assessment of Aging Water Distribution Systems Grant No. ECE-8511399.

**Descriptors:** \*Model studies, \*Simulation analysis, \*Water conveyance, \*Water distribution, Flow rates, Monte Carlo method, Pipelines, Pipes, Pressure head, Uncertainty, Water demand.

The hydraulic reliability of a water distribution system can be defined as the probability that the system can provide the demanded flow rate at the required pressure head. Due to the random nature of future water demands, required pressure heads,

and pipe roughness, the estimation of water distribution system reliability for the future is subject to uncertainty. A methodology has been developed to estimate the nodal and system hydraulic reliabilities of water distribution systems that accounts for these uncertainties. The framework for the methodology is based upon a Monte Carlo simulation consisting of three major components: random number generation, hydraulic network simulation, and computation of reliability. This method was applied successfully to an example water distribution system consisting of 17 pipes and 12 demand nodes. It was determined that this new methodology can be used in the analysis or expansion of existing systems, or the design of new systems. (Author's abstract)  
W91-01495

#### OPTIMIZATION OF HYDROPOWER PLANT INTEGRATION IN WATER SUPPLY SYSTEM.

California Univ., Davis. Dept. of Land, Air and Water Resources.

For primary bibliographic entry see Field 8C.

W91-01556

#### IMPLEMENTATION OF ON-LINE CONTROL SCHEME FOR CITY WATER SYSTEM.

Leicester Polytechnic (England). Water Control Unit.

C.-H. Orr, M. A. Parkar, and S. T. Tennant. Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 708-726, September/October 1990. 5 fig, 11 ref.

**Descriptors:** \*Computer models, \*Control systems, \*Data acquisition, \*Metropolitan water management, \*Water resources management, Cost-benefit analysis, Data transmission, England, Monitoring, Pumping, Urban planning, Water demand, Water distribution, Water resources data, Water supply.

The provision of on-line computer-based control schemes for water supply and distribution systems has for many years eluded the water industry because of the unavailability of reliable applications modules, as well as the limitations on computing power. Recent technological advances, however, have enabled the development and implementation of one such scheme for a major city (Severn-Trent Water) network in the United Kingdom. Specific objectives for such an on-line control implementation include demand prediction based upon predicted demand consumption, management of all the on-line data, coordination of the real-time activities, monitoring of all major system data, generation of appropriate alarm messages and signals, and advice on regulatory decisions during the control period. Preliminary results from the implementation are encouraging. Confidence has increased about the reliability of predicted demand; under normal operation, accuracy is about 5% for the daily average and 10% for the instantaneous values. This has led in turn to increased confidence in the optimality of pump schedules, which on application have led to reduced operational costs. A typical 15% cost saving has been reported, with occasional savings of up to 27%. System monitoring has proved to be of vital importance, giving early warnings of unexpectedly high and low demands, reservoir levels, pump failures, and other unpredictable events. Major improvements through savings in operational costs and provision of system monitoring and regulation facilities have resulted. The cost benefits and improved efficiency have greatly offset the costs of development of such a scheme. (Fish-PTT)  
W91-01559

#### INACTIVATION OF LEGIONELLA PNEUMOPHILA BY POTASSIUM PERMANGANATE.

Arizona Univ., Tucson. Dept. of Microbiology and Immunology.

M. T. Yahya, L. K. Landeen, and C. P. Gerba. Environmental Technology ETLEDB, Vol. 11, No. 7, p 657-662, 1990. 3 tab, 3 fig, 11 ref.

**Descriptors:** \*Disinfection, \*Legionella, \*Pathogenic bacteria, \*Potassium permanganate, \*Water treatment, Chlorination, Hydrogen ion concentration, Microorganisms, Water quality standards.

Effective disinfection of water is essential in order to limit disease transmission. Chlorine, the most popular water disinfectant since the turn of the century, has been found to be effective and economical. However, in the early 1970's, chlorination was found to contribute to the formation of numerous chlorinated organic compounds in water. Potassium permanganate (KMnO<sub>4</sub>), another oxidant, has been used to treat drinking water for almost 100 years. Although potassium permanganate is not currently being used as a primary disinfectant, water systems that use it in the pre-treatment stages of disinfection might benefit from its broad antimicrobial properties and thereby reduce the amount of chlorine needed in the final treatment. Potassium permanganate was investigated for its ability to inactivate cultures of agar-grown *Legionella pneumophila* in a phosphate buffer (pH 6.0 and pH 8.0) at 7 °C. The results of these experiments demonstrate that the efficacy of potassium permanganate is pH-dependent. Greater bacterial rates of inactivation were achieved at the lower pH values. At pH 6.0, significantly higher inactivation rates, *k* values, (0.300 log 10 reduction/min) of *L. pneumophila* were observed compared to those at pH 8.0 (0.032 log 10 reduction/min). By exposure to 5.0 mg/L KMnO<sub>4</sub>, more than a 99% (2 log 10 cfu/mL) reduction in the bacterial numbers was achieved within 10 minutes at a pH of 6.0. However, at pH 8.0, at least 60 minutes was required for a 99% reduction. KMnO<sub>4</sub> was significantly more effective at 5.0 mg/L compared to 2.5 and 1.0 mg/L. Water systems with KMnO<sub>4</sub> may gain disinfection credits as proposed by the EPA. (Korn-PTT)  
W91-01640

#### OCCURRENCE OF THE MUTAGENIC COMPOUND MX IN DRINKING WATER AND ITS REMOVAL BY ACTIVATED CARBON.

Alberta Univ., Edmonton. Dept. of Civil Engineering.

R. C. Andrews, S. A. Dagnault, C. Laverdure, D. T. Williams, and P. M. Huck. Environmental Technology ETLEDB, Vol. 11, No. 7, p 685-694, 1990. 6 fig, 3 tab, 21 ref. Health and Welfare Canada (Supply and Services) Contract Nr. H4001-8-N001/01-SS.

**Descriptors:** \*Activated carbon, \*Drinking water, \*Halogenated compounds, \*Mutagenicity, \*Water treatment, \*Water treatment facilities, Canada, Chlorination, Comparison studies, Organic carbon.

Within the last several years the compound MX (3-chloro-4-dichloromethyl-5-hydroxy-2(5H)-furanone) has been shown to be responsible for up to 57% of the acid fraction mutagenicity observed in chlorinated drinking waters. In aqueous solution, MX can undergo isomerization to an open form known as EMX (E-2-chloro-3-dichloromethyl-4-oxobutenoic acid) which is a weaker mutagen. The use of granular activated carbon (GAC) has been demonstrated to be an effective means of removing mutagenic compounds produced during chlorination of drinking water and as such could be a useful treatment to remove MX. To examine the extent to which MX and EMX are formed in conventional water treatment employing chlorination, and to quantify the removal capacity of GAC for MX, samples were collected from six Canadian water treatment plants. Laboratory investigations showed the strongly mutagenic compound MX to be very well removed by activated carbon over a wide concentration range. Samples obtained from two water treatment plants following pre-chlorination showed MX to be present in the range of 38 to 60 ng/L. MX concentrations were not always correlated with total organic carbon (TOC) levels, suggesting that the type of organic matter present may play a role in MX formation. Granulated activated (GAC) appeared to be capable of removing MX precursors. (Korn-PTT)  
W91-01643

#### INHIBITION OF GROWTH OF LEGIONELLA SPECIES BY HETEROTROPHIC PLATE COUNT BACTERIA ISOLATED FROM CHLORINATED DRINKING WATER.

Queensland Univ., Brisbane (Australia). Dept. of Microbiology.

## Water Treatment and Quality Alteration—Group 5F

S. Toze, L. I. Sly, I. C. MacRae, and J. A. Fuerst. *Current Microbiology CUMIDD*, Vol. 21, No. 2, p 139-143, August 1990. 3 tab, 23 ref.

Descriptors: \*Domestic water, \*Legionella, \*Water quality control, \*Water treatment, Amino acids, Bacteria, Chlorination, Drinking water, Growth rates, Heterotrophic bacteria.

*Legionella* is a nutritionally fastidious bacterium requiring amino acids as the source of energy. A suggested mode of survival in the environment is by the interaction of the *Legionella* cells with non-*Legionella* bacteria. The ability of heterotrophic plate count bacterial strains isolated from chlorinated drinking water on low-nutrient media to inhibit the growth of *Legionella* species was examined. Between 16% and 32% of these strains were able to inhibit the growth of *Legionella* species when tested on buffered charcoal yeast extract agar. The exact proportion of inhibiting strains varied with the individual *Legionella* species. Two strains that inhibited the growth of several *Legionella* species could also stimulate the growth of the same species when both the test strain and the *Legionella* species were grown on buffered charcoal yeast extract agar that lacked the essential amino acid L-cysteine. (Author's abstract) W91-01665

#### LACK OF EFFECT OF DRINKING WATER BARIUM ON CARDIOVASCULAR RISK FACTORS.

Cincinnati Univ., OH. Coll. of Medicine. R. G. Wones, B. L. Stadler, and L. A. Frohman. *Environmental Health Perspectives EVHPAZ*, Vol. 85, p 355-359, April 1990. 1 fig, 1 tab, 24 ref. PHS Grant No. RR00068 and EPA Cooperative Agreement No. CR-812560.

Descriptors: \*Barium, \*Cardiovascular disease, \*Drinking water, \*Human diseases, \*Water pollution effects, Epidemiology, Standards.

Higher cardiovascular mortality has been associated in a single epidemiological study with higher levels of barium in drinking water. Drinking water barium at levels found in some U.S. communities was studied to determine the effect on known risk factors for cardiovascular disease. Eleven healthy men completed a 10-week-dose-response protocol in which diet was controlled (600 mg cholesterol; 40% fat, 40% carbohydrate, 20% protein; sodium and potassium controlled at the subject's pre-protocol estimated intake). Other aspects of the subjects' lifestyles known to affect cardiac risk factors were controlled, and the barium content (as barium chloride) of the drinking water (1.5 L/day) was varied from 0 (first 2 weeks), to 5 ppm (next 4 weeks), to 10 ppm (last 4 weeks). Multiple blood and urine samples, morning and evening blood pressure measurements, and 48-hr electrocardiograph monitoring were performed at each dose of barium. There were no changes in morning or evening systolic or diastolic blood pressures, plasma cholesterol or lipoprotein or apolipoprotein levels, serum potassium or glucose levels, or urine catecholamine levels. There were no arrhythmias related to barium exposure detected on continuous electrocardiographic monitoring. A trend was seen toward increased total serum calcium levels with exposure to barium, which was of borderline statistical significance and of doubtful clinical significance. Drinking water barium at levels of 5 and 10 ppm did not appear to affect any of the known modifiable cardiovascular risk factors. (Author's abstract) W91-01666

#### ANALYSIS OF 228RA AND 226RA IN PUBLIC WATER SUPPLIES BY A GAMMA-RAY SPECTROMETER.

Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering. For primary bibliographic entry see Field 5A. W91-01667

#### FORMATION OF PCDDs AND PCDFs BY THE CHLORINATION OF WATER.

Umea Univ. (Sweden). Inst. of Environmental

Chemistry.

C. Rappe, S. E. Swanson, B. Glas, K. P. Kringstad, and P. deSousa. *Chemosphere CSMHAF*, Vol. 19, No. 12, p 1875-1880, 1989. 2 fig, 1 tab, 11 ref.

Descriptors: \*Chlorination, \*Dioxins, \*Disinfection, \*Polychlorinated biphenyls, \*Wastewater treatment, \*Water pollution sources, \*Water treatment, Analytical methods, Drinking water, Pollutant identification, Pulp and paper industry.

Two samples of tap water and double distilled water were chlorinated using chlorine gas. A series of polychlorinated dibenzofurans (PCDFs) could be identified from these experiments, however no dibenzo-p-dioxins (PCDDs) could be found. Differences were found in the congener profiles between the two water samples that could not be explained. The two water samples gave very similar isomeric patterns (e.g. tetra-CDFs). The three dominating isomers among the tetra-CDFs are the 2,3,7,8-, 1,2,7,8-, and 1,2,8,9-isomers; the same isomers that are found in the bleached pulp and paper products, the 'bleaching pattern'. The observation that PCDFs are formed by the reaction of chlorine with double distilled water indicate that the PCDFs or their precursors are present in the chlorine gas. Consequently all the products formed by chlorination reactions are potentially contaminated by PCDFs. The pattern identified in this study is called the 'chlorine pattern'. For the tetra-CDFs it consists of the same isomers as the 'pulp bleaching pattern', however, the 'chlorine pattern' also contains higher chlorinated PCDFs, but no PCDDs. (Agostine-PTT) W91-01725

#### MEASURING THE PRODUCTIVITY OF CONSTRUCTION MAINTENANCE OPERATIONS.

Rutgers - The State Univ., Piscataway, NJ. Dept. of Industrial Engineering. J. T. Luxhoj, and P.-C. Tao. *Journal of the American Water Works Association JAWWA5*, Vol. 82, No. 8, p 35-39, August 1990. 3 fig, 6 tab.

Descriptors: \*Construction, \*Maintenance, \*Metropolitan water management, \*Performance evaluation, \*Productivity, \*Utilities, \*Water treatment, Model studies, Personnel management.

A measurement system for evaluating and controlling a water utility's maintenance activities was developed. The system involves the development of models to graphically describe and measure the work content of the various jobs. The first set of models, which focuses on task descriptions, comprises the construction measurement system. The second set of models comprises the performance measurement system and is developed at the department level to measure labor productivity. The construction and performance measurement system is currently in place at Hackensack Water Company. During the first six months of 1989, a 20 percent productivity gain was reported over the same period in 1988. During the first half of 1989, 300 more jobs were completed and 650 fewer worker hours were expended than during the same period in 1988. The backlog index was reduced to 2.4 from 4.0. Although it is not clear at this point how much of the productivity improvement can be directly attributed to the measurement system, it is reasonable to conclude that such a measurement system has significantly increased the productivity consciousness of the organization. (Agostine-PTT) W91-01749

#### OPERATOR EVALUATION OF SMALL SYSTEMS.

Chautauqua County Dept. of Health, Mayville, NY. Div. of Environmental Health Services. W. D. Gollnitz, and B. Kittle. *Journal of the American Water Works Association JAWWA5*, Vol. 82, No. 8, p 40-45, August 1990. 3 fig, 1 tab, 13 ref.

Descriptors: \*Operating policies, \*Performance evaluation, \*Water treatment, \*Water treatment facilities, Case studies, Clarifiers, Evaluation, Particulate matter, Turbidity, Water quality standards.

Many of the small water treatment systems built before 1960 are having difficulty meeting current water quality regulations, especially with respect to particle reduction (measured as finished-water turbidity). Preliminary evaluations of small surface water treatment systems can and should be performed by system managers and operators before a consulting engineer is hired. System evaluations can be aided by conducting literature searches at local libraries and universities to get a better understanding of the potential problem facing the utility, by reviewing and comparing the design of the treatment system in question with those of neighboring systems treating water of similar quality, by performing system simulations using models of varying complexity, and by conducting evaluations in the treatment plant using different coagulants and coagulant aids. A case study of a water treatment plant in Westfield, N.Y. is described in which the simulation techniques are demonstrated. For the facility to meet the current and proposed turbidity maximum contaminant levels, the existing clarifier must be modified by adding tube settlers or by adding an additional clarification unit. (Agostine-PTT) W91-01750

#### MEASURING AND MODELING VARIATIONS IN DISTRIBUTION SYSTEM WATER QUALITY.

Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div. R. M. Clark, and J. A. Coyle. *Journal of the American Water Works Association JAWWA5*, Vol. 82, No. 8, p 46-53, August 1990. 6 fig, 36 ref.

Descriptors: \*Model studies, \*Water distribution, \*Water quality management, \*Water sampling, \*Water treatment, Flow pattern, Hydraulics, Monitoring, Pennsylvania.

The effects of hydraulic mixing on water quality variations in a distribution system were examined. The study, which was conducted at the North Penn Water Authority, Lansdale, Pennsylvania, (average production of 5 mgd and 225 mi of distribution pipe), incorporated a field sampling program that utilized customized automated samplers designed to prevent loss of volatile constituents. As a complement to the field sampling program, computer models that would predict water quality variations in distribution systems were examined and developed. A clear need was shown for obtaining more representative monitoring results than are normally acquired from distribution system sampling. It is concluded that steady-state predictive modeling of water quality can provide insight into overall water quality variations and patterns within a distribution system. Interpretation of predictive modeling results must be made in light of an appreciation of system hydraulics, in particular an understanding of the flow patterns and directions that create the gradients of concentration. (Agostine-PTT) W91-01751

#### FLOCCULATION IN TURBULENT FLOW: MEASUREMENT AND MODELING OF PARTICLE SIZE DISTRIBUTIONS.

Pittsburgh Univ., PA. Dept. of Civil Engineering. L. W. Casson, and D. F. Lawler. *Journal of the American Water Works Association JAWWA5*, Vol. 82, No. 8, p 54-68, August 1990. 15 fig, 21 ref. NSF Presidential Young Investigator Grant CES 8451135.

Descriptors: \*Flocculation, \*Model studies, \*Particle size, \*Turbulent flow, \*Water treatment, Eddies, Mixing, Statistical analysis, Suspension, Velocity, Water quality.

Fluid motion in an oscillating-grid flocculator was investigated quantitatively with a laser Doppler velocimeter for two mixing conditions. Batch flocculation experiments were performed for monodisperse, bimodal, and trimodal latex suspensions. The effects of mixing intensity, particle charge, and suspension concentration on the rate of change in particle size distributions were studied. Experiments

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5F—Water Treatment and Quality Alteration

tal results indicated that large eddies are relatively unimportant for flocculation and that flocculation is induced by eddies of approximately the same size as the particles. A method for estimating the velocity gradients in eddies of different sizes in the flow was developed and incorporated into an existing mathematical model for flocculation. The predictions of the revised flocculation model were compared with the experimental results and indicated that the velocity gradients of the eddies adequately describe the interparticle contacts resulting from mixing during flocculation. (Author's abstract) W91-01752

#### INFLUENCE OF OZONATED NATURAL ORGANIC MATTER ON THE BIODEGRADATION OF A MICROPOLLUTANT IN A GAC BED.

Weston (Roy F.), Inc., Valhalla, NY.  
J. E. DeWaters, and F. A. DiGiano.  
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 8, p 69-75, August 1990. 7 fig, 1 tab, 23 ref. NSF Grant ECE-8520483.

Descriptors: \*Activated carbon, \*Biodegradation, \*Granular activated carbon, \*Organic matter, \*Ozonation, \*Water treatment, Biofilms, Industrial wastes, Pollutants, Sorption.

Biological activity on granular activated carbon (GAC) may significantly enhance the treatment process. Shifting the pathway for contaminant removal from adsorption to biodegradation reduces biodegradable organics and increases sorptive capacity for non-degradable or slowly degradable compounds. Biodegradation and adsorption of natural organic matter (NOM) were studied in a laboratory-scale GAC reactor. Investigations were done under controlled laboratory conditions in which feed concentration and empty bed contact time (EBCT) could be varied and a synthetic organic chemical (SOC) could be introduced. Ozonation of the NOM used in this research at a dose of 1 mg O<sub>3</sub>/mg TOC (total organic carbon) increased biodegradation and encouraged biofilm growth in the GAC bed. Substantial steady-state reductions in TOC were achieved within a relatively short EBCT in the presence of this actively growing biofilm. Significant removal of organic matter within a short EBCT implies that biological activity has the potential for reducing the necessary size of a GAC facility, thereby reducing capital costs. Biofilm grown on ozonated NOM readily degraded trace concentrations of phenol. It is concluded that the biological activity provided by a readily available substrate (ozonated NOM) can effectively remove not only the bulk substrate but trace synthetic organics as well. (Agostine-PTT) W91-01753

#### RECOVERY OF MINERAL SALTS AND POTABLE WATER FROM DESALTING PLANT EFFLUENTS BY EVAPORATION: PART I. EVALUATION OF THE PHYSICAL PROPERTIES OF HIGHLY CONCENTRATED BRINES.

University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Chemical Engineering. For primary bibliographic entry see Field 3A. W91-01757

#### EFFECTS OF OZONE ON THE INFECTIVITY OF HEPATITIS A VIRUS.

New England Univ., Biddeford, ME. Dept. of Microbiology.  
J. M. Vaughn, Y. S. Chen, J. F. Novotny, and D. Strout.

Canadian Journal of Microbiology CJMIAZ, Vol. 36, No. 8, p 557-560, August 1990. 1 fig, 1 tab, 34 ref. EPA Grant R-812140-01.

Descriptors: \*Disinfection, \*Enteroviruses, \*Hydrogen ion concentration, \*Infection, \*Ozone, Disinfectants, Human pathogens, Immunoassay, Water treatment.

The inactivation of a large-focus-forming variant of hepatitis A virus (HM-175) by ozone was investigated as an alternative to chlorine for the disinfection of water and wastewater. Experiments using mainly single-particle virus preparations sus-

pended in phosphate-carbonate buffer were conducted over a range of pH levels (6-8) at 4 C. Viral enumerations involved the use of a radioimmunoassay. While some tolerance to lower (i.e., 0.1-0.5 mg/L) ozone residuals was noted, the exposure of virus particles to ozone concentrations of 1 mg/L or greater at all pH levels resulted in their complete (5 log) inactivation within 60 seconds. The pH-related effects that were observed were not considered to be significant. (Author's abstract) W91-01771

#### DETERMINATION OF VOLATILE ORGANICS IN DRINKING WATER WITH USEPA METHOD 524.2 AND THE ION TRAP DETECTOR.

Environmental Monitoring Systems Lab., Cincinnati, OH.

J. W. Eichelberger, T. A. Bellar, J. P. Donnelly, and W. L. Budde.  
Journal of Chromatographic Science JCHSBZ, Vol. 28, No. 9, p 460-467, September 1990. 9 fig, 3 tab, 9 ref.

Descriptors: \*Drinking water, \*Ion trap detector, \*Laboratory methods, \*Pollutant identification, \*Volatile organic compounds, \*Water treatment, Chemical analysis, Mass spectrometry, Maximum contaminant levels, Measuring instruments, Monitoring.

New drinking water regulations require the monitoring of eight volatile organic compounds that have established maximum contaminant levels (MCLs), and 51 other volatile organics for which MCLs are not established. A laboratory analytical method (method 524.2) for the determination of 58 of these compounds is investigated which uses: a standard inert gas purge extraction; isolation of the volatile organics on a three stage solid-phase trap; thermal desorption into a gas chromatograph; separation with the fused silica capillary column; and identification and measurement with a relatively low cost, bench-top ion trap detector that functions as a mass spectrometer. At a concentration of 2 micrograms/L (2 ppb), the grand mean measurement accuracy for 54 compounds was 95% of the true value with a mean relative standard deviation (RSD) of 4%. At 0.2 micrograms/L (200 parts per trillion), the grand mean measurement accuracy was 95% of the true value with a mean RSD of 3%. (Author's abstract) W91-01915

#### COMPREHENSIVE HEALTH EFFECTS TESTING PROGRAM FOR DENVER'S POTABLE WATER REUSE DEMONSTRATION PROJECT.

Denver Water Dept., CO.  
For primary bibliographic entry see Field 5D. W91-01920

### 5G. Water Quality Control

#### MODELING LINKED WATERSHED AND LAKE PROCESSES FOR WATER QUALITY MANAGEMENT DECISIONS.

Agricultural Research Service, Durant, OK.  
R. M. Summer, C. V. Alonso, and R. A. Young.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 421-427, July/September 1990. 9 fig, 2 tab, 26 ref.

Descriptors: \*Computer models, \*Lake management, \*Limnology, \*Management planning, \*Minnesota, \*Model studies, \*Water quality management, \*Watershed management, Decision making, Land use, Physical models, Simulation analysis.

A physically based modeling approach is used to link watershed with lake processes and to simulate their responses to land management and weather conditions. Components of the watershed model, AGNPS (agricultural non-point source model) are hydrology, erosion, sediment transport, transport of nitrogen and phosphorus, and chemical oxygen demand. Runoff, sediment, and chemical variables from the watershed were used to provide input to a lake model with a cellular structure. This one-

dimensional model of water bodies simulates temperature stratification, mixing by wind, sedimentation, inflow density current, and algal growth. Unsteady advection-diffusion equations characterize the dynamics of suspended sediment, soluble and sediment-attached N and P, and chlorophyll. This model, AGNPS-LAKE, is driven by random generation of weather conditions on a daily basis. Resulting impacts of alternative management plans were simulated by changing agricultural practices and land use, thereby modifying inflow characteristics to a lake. Modeling capabilities are being tested on eutrophic lakes in Minnesota for the purpose of simulating long-term trends and impacts of best management practices. (Author's abstract) W91-01012

#### ASSESSMENT OF MANAGEMENT PRACTICES FOR REDUCING PESTICIDE RUNOFF FROM SLOPING CROPLAND IN ILLINOIS.

Illinois Natural History Survey, Champaign.  
A. S. Felsot, J. K. Mitchell, and A. L. Kenimer.  
Journal of Environmental Quality JEVQAA, Vol. 19, No. 3, p 539-545, July/September 1990. 2 fig, 7 tab, 49 ref. North Central Regional Pesticide Impact Assessment Program Grant ILLU-12-0214, University of Illinois Water Resources Center Grant G1015-02, Southern Regional Research Project S-218.

Descriptors: \*Agricultural practices, \*Agricultural runoff, \*Illinois, \*Path of pollutants, \*Pesticides, \*Water pollution, \*Water pollution control, \*Water pollution prevention, Adsorption, Alachlor, Carbofuran, Conservation, Contour terracing, Cultivation, Sediment contamination, Simulated rainfall, Slopes, Soil contamination, Surface runoff, Terbufos, Tillage, Transport.

The influence of tillage system and contouring practice on runoff of soil-applied alachlor, carbofuran, and terbufos from small plots (30 sq m) were studied using a rainfall simulator. Plots were planted in corn (Zea mays L.) in 1983, soybean (Glycine max (L.) Merr.) in 1984, and corn in 1985. Runoff was measured during a 60 min event with a rainfall intensity of 63 mm/h. During 1984, moldboard-plowed and no-till systems were studied with rows oriented on the contour or up-and-down slope (7-11% slope). Compared to moldboard-plow, up-and-down slope no-till and contouring significantly reduced runoff of carbofuran and alachlor. Percentage of applied carbofuran lost in runoff and sediment ranged from 1% (contoured moldboard) to 11% (up-and-down slope moldboard). Percentage of alachlor lost ranged from 1% (contoured no-till) to 2% (contoured moldboard). During 1985, the effects of row orientation were evaluated on moldboard-plow, chisel-plow, ridge-till, strip-till, and no-till systems. Under up-and-down slope conditions, runoff of alachlor and terbufos plus two metabolites (terbufos sulfoxide and terbufos sulfone) was significantly reduced by strip-till (<1% loss) compared to moldboard-plow (6% loss). With contouring, ridge tillage also was effective in reducing pesticide runoff (<1% of applied pesticide), and strip-till held losses to <0.1%. Alachlor and carbofuran were translocated from plots largely in moving water, but terbufos and metabolites were recovered mainly in eroded sediment. Although no conservation tillage system completely eliminated pesticide runoff, losses were most effectively minimized by contoured strip-till and no-till, which controlled both water and sediment movement. (Author's abstract) W91-01021

#### ALDICARB FOOD POISONINGS IN CALIFORNIA, 1985-1988: TOXICITY ESTIMATES FOR HUMANS.

California Dept. of Health Services, Emeryville. Environmental Epidemiology and Toxicology Branch.

For primary bibliographic entry see Field 5C. W91-01052

#### BALANCE OF REPRESENTATION IN WATER PLANNING: AN ASSESSMENT OF EXPERIENCE FROM NORTH CAROLINA.

## Water Quality Control—Group 5G

Florida State Univ., Tallahassee. Dept. of Urban and Regional Planning.  
For primary bibliographic entry see Field 6A.  
W91-01059

**POLYCYCLIC AROMATIC HYDROCARBON EMISSIONS FROM THE COMBUSTION OF CRUDE OIL ON WATER.**

National Inst. of Standards and Technology (NEL), Gaithersburg, MD.  
For primary bibliographic entry see Field 5B.  
W91-01066

**IMPORTANCE OF NATURAL PROCESSES IN UNDERSTANDING ECOSYSTEM CHANGE: A CASE STUDY OF LIMED LAKES.**

Illinois State Water Survey Div., Champaign.  
For primary bibliographic entry see Field 2H.  
W91-01073

**BERSANI V. EPA: TOWARD A PLAUSIBLE INTERPRETATION OF THE 404(b)(1) GUIDELINES FOR EVALUATING PERMIT APPLICATIONS FOR WETLAND DEVELOPMENT.**

H. Wendel.  
Columbia Journal of Environmental Law CJELE, Vol. 15, No. 1, p 99-119, 1990.

Descriptors: \*Conservation, \*Environmental protection, \*Judicial decisions, \*Legal aspects, \*Massachusetts, \*Resource management, \*Wetlands, Permits, Public rights, Zoning.

The rapid destruction of the wetland wealth of the United States that began with European settlement continues despite the enactment of a federal law to prevent it. One recent case is Bersani v. EPA, a Second Circuit decision that spared from development a red maple swamp in Massachusetts. Bersani involved the Environmental Protection Agency's veto of a permit to fill a wetland area on the grounds that an alternative was available when the developer entered the market for a site. The developer claimed that the relevant time for consideration of whether alternative sites were available to him was when he applied for a permit rather than when he entered the market in search of a site. The Army Corps of Engineers (as apparent enforcer of the law) approach to the balance embodied in the guidelines between the developer's interest and the social interest in wetland values can be described as a private interest approach, characterized by three elements: treatment of the alternatives analysis as the central provision of the guidelines; characterization of alternatives as practicable or not practicable based upon the absolute size of the loss of prospective profits entailed by the alternative; and approval of a permit to develop when no practicable alternative is deemed to exist. The guidelines are meant to implement Section 404's intent as a wetland protection law. Bersani v. EPA comes closer to implementing a social cost-benefit analysis and activating the incentive mechanism necessary to perform an alternatives analysis than do prior decisions of the Corps and the courts. The timing issue of the alternatives analysis of the 404(b)(1) guidelines fails to focus on any of the criteria crucial to determining the availability of practicable alternatives to a developer's proposed wetland site. It is hoped that the positive movement taken by the case toward protecting society's strong interests in wetlands will be continued and accelerated in future court review of wetland permit determination. (Brunone-PTT)  
W91-01092

**STEMMING THE TIDE OF MARINE DEBRIS POLLUTION: PUTTING DOMESTIC AND INTERNATIONAL CONTROL AUTHORITIES TO WORK.**

Perkins Coie, Washington, DC.  
D. C. Baur, and S. Iudicello.  
Ecology Law Quarterly ECLQAR, Vol. 17, No. 1, p 71-142, 1990.

Descriptors: \*International law, \*Marine pollution, \*Public participation, \*Solid waste disposal, \*Water pollution control, Degradation, Jurisdiction, Public rights, Recycling.

Oceans and coastal seas have long been used as receptacles for all kinds of waste materials. Once the scope and impacts of persistent marine debris pollution became apparent, political institutions responded quickly. Annex V of the International Convention for the Prevention of Pollution from Ships Protocol entered into force after nine years of delay, and Congress enacted tough marine pollution control laws, including the Marine Plastic Pollution Research and Control Act. Lasting success in reducing marine debris depends primarily on translating current public awareness of the marine debris problem into modifications of the way people conduct their everyday activities. Ways to change this attitude and thus to lessen the impact of commonly pursued waste disposal activities on the marine environment include source reduction, recycling, and the judicious use of environmentally safe degradable material. All three ways call for instillation of public understanding of the problems presented by solid waste disposal practices in the vicinity of the ocean and coastal areas. Public education is central to capitalizing on public concern for the marine environment. Over time, however, institutional mechanisms will be needed to sustain this concern and force action. Incentives can be marshaled to encourage recycling, source reduction, and the use of degradable materials. Command and control authorities can mandate waste restrictions and other useful measures. Prompt and thorough action can keep beaches and waters free of debris long after washups of medical waste and plastic trash have become a distant memory. (Brunone-PTT)  
W91-01093

**EPA'S PESTICIDES-IN-GROUNDWATER STRATEGY: AGENCY ACTION IN THE FACE OF CONGRESSIONAL INACTION.**

R. J. Sater.  
Ecology Law Quarterly ECLQAR, Vol. 17, No. 2, p 143-177, 1990.

Descriptors: \*Cleanup operations, \*Contamination, \*Environmental protection, \*Groundwater pollution, \*Pesticides, Agriculture, Aldicarb, Clean Water Act, Comprehensive Environmental Response Com., Dibromochloropropane, Drinking water, Federal Insecticide Fungicide and Rodent, Regulations, Safe Drinking Water Act, Wells.

Until a decade ago, contamination of groundwater by pesticides was not considered a serious health or environmental threat. This belief was shattered in 1979 when the pesticide dibromochloropropane (DBCP) was found in nearly 2500 wells and municipal drinking water systems in California, and aldicarb was found in wells in New York. In both cases, pesticides had entered the water supply through approved agricultural uses, not accidental spills or leaks. The EPA now considers pesticide contamination of groundwater a serious threat, and has developed its own regulatory program to deal with the problem: Agricultural Chemicals in Groundwater: Proposed Pesticide Strategy. The Pesticide Strategy develops a regulatory system that uses a combination of state pesticide management plans and federal groundwater quality standards (the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Federal Water Pollution Control Act (Clean Water Act or CWA), the Safe Drinking Water Act (SDWA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)) to control pesticide contamination of groundwater. In theory, the EPA's Pesticide Strategy's pesticide-specific and site-specific approach leads to an exact fit between regulation and regulatory need, minimizing both underregulation and overregulation. In practice, however, the fine-tuned regulation demands state resources and political support for plan development, monitoring, and enforcement. A more sound approach to pesticide contamination of groundwater would be FIFRA's national cancellation for pesticides that pose significant health and environmental risks. National cancellation ensures the protection of groundwater, while compensating for the inefficiency of overregulation by reducing groundwater sites requiring public or private cleanup efforts. Although the Pesticide Strategy may ultimately fail, EPA's experience with it will provide many lessons for policymakers trying to

respond to complex environmental problems. (Brunone-PTT)  
W91-01094

**CLEAN WATER ACT: A GOOD BEGINNING.**

L. G. Billings.  
Environmental Forum ENVFEN, Vol. 7, No. 2, p 46-48, March/April 1990.

Descriptors: \*Clean Water Act, \*Public participation, \*Water quality standards, \*Zero discharge, Chemical wastes, Economic aspects, Federal jurisdiction, Pesticides, Runoff, Water pollution.

Senator Edmund Muskie channelled public outrage into the passage of the landmark 1972 Clean Water Act (CWA), which set a national goal of zero discharge of pollutants. It is brought to public attention the fact that water is not a free good and its supply is extremely limited; public drinking water drawn from wells is often unsafe; and chemical contaminants in the water supply are a basic public health threat. Runoff pollution problems have been created by the establishment of more impervious surfaces like roads and parking lots and the increased use of chemicals and pesticides. Twenty years ago, a group of politicians developed a clean water policy based on three broad goals: the biological integrity of receiving waters, the maximum use of available technology, and the ultimate goal of zero discharge. Achieving these goals depended on state authority, federal mandates, citizen suits, and public funding. The single most contentious CWA issue was whether there would be an opportunity for individual polluters to appeal clean water requirements for their particular category of facilities, and was ultimately resolved in favor of categorical effluent standards based on feasibility and cost. For approximately ten billion dollars per year, nearly three quarters of the nation's surface water now meets the national water quality standard. Significant progress has been made as a result of a federal-state partnership, federal financial aid, and federal enforcement. The Environmental Protection Agency has recently, however, been advocating source-by-source waivers, cost-based appeals, pre-cooked risk assessments, and an impossible array of pollution reduction credits, tax law-type carry-forwards and carry backs, and compliance shields designed to minimize rather than maximize federal responsibility for public health related pollution control. A potential solution to the problem of decreased accessibility of members of Congress is the development of a viable Green Party in the USA, which would refocus public attention upon the problems of pollution control and maintenance of clean water. (Brunone-PTT)  
W91-01095

**MURKY STANDARDS FOR GROUNDWATER.**

Pennsylvania Dept. of Environmental Resources, Harrisburg. Bureau of Hazardous Sites and Superfund Enforcement.  
For primary bibliographic entry see Field 2F.  
W91-01096

**INTEGRATED ANALYSIS OF POLICY OPTIONS FOR PROTECTION OF GROUNDWATER QUALITY.**

Economic Research Service, Washington, DC. Resources and Technology Div.  
N. D. Uri, and W. Y. Huang.  
Environmental Geology and Water Sciences EGWSEI, Vol. 15, No. 3, p 233-241, May/June 1990. 1 fig, 1 tab, 33 ref.

Descriptors: \*Groundwater quality, \*Groundwater resources, \*Model studies, \*Policy making, \*Resource management, \*Water pollution control, \*Water quality control, Fertilizers, Human diseases, Pesticides, Political aspects, Public participation.

A regional authority should use an integrated framework when assessing the potential impacts of any policy initiative directed at improving groundwater quality. A policy model was therefore developed relying on three decision components (farmland production decisions model, a household de-

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5G—Water Quality Control

cisions model, and a regional policy decision model) where the objective is one of identifying the trade-offs that a regional authority will be confronted with as it strives to balance the preferences of farmers and households while endeavoring to maximize net economic welfare. The basic rule developed indicates that the regional authority must choose a policy whereby any increase (decrease) in regional income is just equal to the decrease (increase) in net benefits to households. The model developed does require a fair amount of information on the transport and fate of pesticides and fertilizers used in the agricultural production process, dose-response relationships for computing health risks and costs associated with excessive illnesses (and mortality), costs of remedial action options etc. (Author's abstract)  
W91-01101

**ENFORCEMENT OF FEDERAL UNDERGROUND STORAGE TANK REGULATIONS.**  
North Carolina Univ. at Wilmington. Dept. of Philosophy.  
C. C. Gauthier.  
Environmental Law EVLWA8, Vol. 20, No. 2, p 261-289, 1990.

Descriptors: \*Enforcement, \*Leakage, \*Path of pollutants, \*Regulations, \*Underground storage tanks, \*Water pollution prevention, Biodegradation, Economic aspects, Environmental protection, Federal jurisdiction, Flushing, Groundwater pollution, Hydrocarbons, Liability, Political aspects, Soil contamination, State jurisdiction.

During the 1980s, underground storage tanks (USTs) were leaking petroleum products into the soil and groundwater at an alarming rate. In 1986, the EPA tested 433 tanks for leakage at 218 establishments in the United States and found that 35% of the storage tanks tested were leaking. These releases both damage the environment and pose serious risks to public health and safety. The federal government has recently developed an UST regulatory program that includes operating and financial responsibility requirements. Federal regulation requires UST system owners to notify state environmental agencies of the existence of these systems, and directs the EPA to formulate regulations concerning UST release detection, prevention, and corrective action, as well as for financial responsibility for leaks of regulated substances from USTs. State environmental agencies are required to compile tank inventories and to provide this information to the EPA. The EPA is mandated to establish a federal program for the regulation of USTs that allows state programs to operate in lieu of the federal program if they are no less strict than the federal requirements and can be adequately enforced. When a petroleum product is released from an underground storage tank, there is contamination of the soil, and if the release is significant, there is also contamination of the groundwater. To recover shallow spills, the contaminated soil may be excavated and placed in a landfill. For deeper pollution, the only methods of treatment are flushing and recovery or an in-situ treatment, such as biological degradation using bacteria. Ethical issues include the relationship between the public demand for petroleum products, environmental damage, and the conflicts encountered by environmental consulting firms. Legal issues concern the notification of the public and the sale of property on which storage tanks are located, as well as the increasing involvement of the legal system in enforcement of environmental legislation. (Brunone-PTT)  
W91-01103

**MARINE RESERVE MANAGEMENT IN DEVELOPING NATIONS: MIDA CREEK—A CASE STUDY FROM EAST AFRICA.**  
Exeter Univ. (England). Dept. of Biological Sciences.  
For primary bibliographic entry see Field 6E.  
W91-01121

**UNITED STATES V. LARKINS: CONFLICT BETWEEN WETLAND PROTECTION AND AGRICULTURE; EXPLORATION OF THE FARM-**

**ING EXEMPTION TO THE CLEAN WATER ACT'S SECTION 404 PERMIT REQUIREMENTS.**  
For primary bibliographic entry see Field 6E.  
W91-01123

**GROUND-WATER PROTECTION AND RECLAMATION.**  
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.  
Journal of Environmental Engineering (ASCE) JOEEDU, Vol. 116, No. 4, p 654-662, July/August 1990. 3 tab, 14 ref.

Descriptors: \*Groundwater, \*Groundwater availability, \*Groundwater management, \*Groundwater pollution, \*Water pollution prevention, \*Water pollution treatment, Aquifers, Groundwater contamination, Groundwater quality, Water management, Water treatment.

A review of the status of the nation's groundwater quality and pollution problems reveals the need to be concerned for its protection and to have clean-up technologies available for existing and future contamination problems. Present U.S. federal laws are more than adequate to protect and clean up the nation's groundwaters; compliance with existing groundwater pollution prevention legislation will be most effective. While national interest in the protection and cleanup of the nation's groundwaters is well justified, panic over the current status of groundwaters quality is not. Research needs to be expanded on how to prevent substances from being released to the environment during handling, treatment, storage, or disposal with specific emphasis, in loss control, along with continued efforts to develop and refine methodologies to clean up contaminated soils and aquifers. (King-PTT)  
W91-01152

**IMMOBILIZATION MECHANISMS IN SOLIDIFICATION/STABILIZATION OF CD AND PB SALTS USING PORTLAND CEMENT FIXING AGENTS.**  
Louisiana State Univ., Baton Rouge. Dept. of Chemistry.  
F. K. Cartledge, L. G. Butler, D. Chalasani, H. C. Eaton, and F. P. Frey.  
Environmental Science and Technology ESTHAG, Vol. 24, No. 6, p 867-873, June 1990. 3 fig, 2 tab, 32 ref.

Descriptors: \*Cadmium, \*Lead, \*Portland cements, \*Solid waste disposal, \*Water pollution prevention, Groundwater pollution, Land disposal, Leaching, Path of pollutants, Sludge stabilization.

Cement is often used in solidification/stabilization (S/S) treatment of hazardous heavy-metal-containing wastes that are in liquid or sludge forms to produce a solid for land disposal. Analysis of the behavior of Cd and Pb salts during cement-based solidification, using the toxicity characteristic leaching procedure, conduction calorimetry, and solid-state nuclear magnetic resonance, demonstrated that although the concentration of Cd in leachates is very low, the Pb concentration is much higher and represents a serious threat to groundwater. While cadmium salts, whether initially water soluble or insoluble, are effectively immobilized by the cementitious process, lead hydroxide is not. In addition, particularly with mixed waste streams, other components have been previously shown to impair optimal waste immobilization by adverse effect on strength development of the cement matrix. The combined results suggest cautionary use of cement-based solidification. (D'Agostino-PTT)  
W91-01182

**PROCEEDINGS OF STORMWATER AND WATER QUALITY MODEL USERS GROUP MEETING.**  
For primary bibliographic entry see Field 5G.  
W91-01188

**PROCEEDINGS OF STORMWATER AND WATER QUALITY MODEL USERS GROUP MEETING.**

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-195002. Price codes: A11 in paper copy, A01 in microfiche. October 3-4, 1988, Denver, Colorado. EPA Report No. EPA/600/9-89/001, January 1989. 233 p. Edited by C. Y. James, Ben R. Urbanas, and Thomas O. Barnwell.

Descriptors: \*Management planning, \*Model studies, \*Storm water, \*Storm water management, \*Urban hydrology, \*Urban runoff, \*Water quality management, Computer models, Computer programs, Computers, Conferences, Data interpretation, Field tests, Hydraulic models, Mathematical models, Water quality.

Twenty-two technical papers are presented on topics related to the development and application of computer-based mathematical models for water quality and quantity management. The papers address five subject areas: revisions and modifications to EPA models, administrative concerns, applications and experiences, latest developments, and field observations and related studies. Several of the studies present critical reviews of modeling concepts, numerical approaches, and comparisons with field observations. Revisions and modifications of the EPA SWMM model are helpful in the enhancement of the model's capability and user friendliness. Although the application of computer models is the prime subject area, many other subjects, such as spreadsheet use, statistical sensitivity of measured data, AUTOCAD enhancement in data management, and mapping database application, are addressed. (See W91-01189 thru W91-01210) (Author's abstract)  
W91-01188

**IMPROVEMENTS TO SURCHARGE CALCULATIONS IN EXTRAN.**  
Brown and Caldwell, Seattle, WA.  
For primary bibliographic entry see Field 7C.  
W91-01192

**APPLICATION OF QUAL II TO EXPLORE WASTELOAD ALLOCATION ALTERNATIVES.**  
Rhode Island Dept. of Environmental Management, Providence.  
A. S. Liberti, R. M. Wright, and K. Scott.  
IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 81-91, 4 fig, 1 tab, 5 ref.

Descriptors: \*Model studies, \*Patuxent River, \*Urban hydrology, \*Urban runoff, \*Water quality, \*Water quality management, Aeration, Biochemical oxygen demand, Dissolved oxygen, Flow profiles, Management planning, Nitrites, Pollution load, Simulation analysis, Urban watersheds.

The Patuxent River flows through heavily urbanized areas, receives effluent from 3 municipal wastewater treatment facilities (WWTFs) and one industrial WWTF, and has summer dissolved oxygen (DO) concentrations well below the 5.0 mg/L standard for much of its length. Data collected during three 48 hour sampling surveys was used to calibrate and validate the QUAL-II model. A review was conducted of the model calibration and validation and it was noted that although biochemical oxygen demand (BOD) decay and nitrification rates were calculated from field data, they varied greatly among surveys for a given reach, and between adjacent reaches. To provide a more defendable wasteload allocation (WLA), the model was recalibrated and revalidated using one set of decay rates which successfully predicted the field data. The data used to revalidate the model was collected during a flow profile very close to the 7Q10 flow and alternative WLA strategies were explored using this model. Flow augmentation, instream aeration, increasing the number of outfalls, and advanced treatment (AT) simulations indicated that discharge limits of BOD 10, NH3 2 mg/L are required to attain the instream DO criteria. Seasonal limits were developed using monthly USGS flow and temperature data. When simulating AT, effluent DO concentrations were set to 6.0 mg/L and instream BOD decay and simulated

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oxygen demand (SOD) rates were reduced. (See also W91-01188) (Author's abstract)  
W91-01197

### FREQUENCY ANALYSIS OF TRACE LEVEL WATER QUALITY DATA WITH A TIME VARYING CENSORING LEVEL.

Merrick and Co., Denver, CO.  
For primary bibliographic entry see Field 5B.  
W91-01198

### APPLICATION OF THE HSPF MODEL TO WATER MANAGEMENT IN AFRICA.

University of the Pacific, Stockton, CA. School of Engineering.  
For primary bibliographic entry see Field 6B.  
W91-01199

### MULTI-MODEL MICRO-COMPUTER BASED WET DETENTION BASIN DESIGN METHODOLOGY.

North Carolina Dept. of Natural Resources and Community Development, Raleigh. Div. of Environmental Management.  
For primary bibliographic entry see Field 4C.  
W91-01200

### MODELING AND FIELD EVALUATIONS OF URBAN WET DETENTION PONDS.

North Carolina Univ. at Charlotte. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 4C.  
W91-01201

### WATERSHED 89: THE FUTURE FOR WATER QUALITY IN EUROPE. VOLUME II.

Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York, 1989. 521p. Edited by D. Wheeler, M. L. Richardson, and J. Bridges.

Descriptors: \*Europe, \*Eutrophication, \*Wastewater treatment, \*Water pollution control, \*Water pollution prevention, \*Water quality, Animal wastes, Enteric bacteria, Groundwater pollution, Models, Path of pollutants, Pesticides, Pollutant identification, Potable water, Viruses, Water pollution effects.

Watershed 89 brought together scientists, engineers, environmentalists, industrialists, academia and politicians to provide a forum for a wide range of opinions concerning water quality in Europe. This book contains proceedings from the conference sponsored by the Commission of the European Communities, the World Health Organization and the International Association on Water Pollution Research and Control and organized by the Robens Institute, University of Surrey. A declaration agreed upon by conference participants states that professionals concerned with water quality have made substantial progress since the middle of the last century. New problems threatening water quality have resulted from significant changes in society in the last forty years. Problems of mercury and polychlorinated biphenyl pollution have been dealt with, but solutions to the other problems, such as pesticides, cadmium, eutrophication, enteric viruses and parasites will necessitate changing some of society's established practices. There is a need to better anticipate new problems, especially those dealing with the extent to which groundwaters will ultimately become contaminated by solvents, metals or other toxic substances, thereby necessitating the installation of new water treatment technologies or abandonment of sources. The conference concluded that: (1) water pollution prevention was better than having to rehabilitate polluted waters, (2) guidelines for water quality must be taken seriously and enforced, (3) water quality guidelines must take into account the dissimilar impacts on human health and the ecology of flora and fauna, (4) research must be coordinated on a national and international level, (5) each citizen of Europe has the right to be adequately informed concerning the status and trends of the environment in relation to human health, (6) all nations must make substantial investments in human re-

sources to meet the need for increased monitoring and enforcement of standards and guidelines, and (7) guidelines and regulations are important, but they do not remove the need for political choices. (See W91-01212 thru W90-01255) (Geiger-PTT)  
W91-01211

### Q2X: AN (EXPERT) SYSTEMS APPROACH TO QUANTITY AND QUALITY MANAGEMENT OF STRATEGIC RESOURCES.

Surrey Univ., Guildford (England). Centre for Information Technology Research.  
K. Ahmad.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York, 1989. p 129-145, 15 fig, 3 tab, 10 ref.

Descriptors: \*Computers, \*Expert systems, \*Water pollution control, \*Water quality, \*Water resources management, Computer programs, Management planning, Monitoring, Quality control, Water distribution, Water supply.

Expert systems methods, tools and techniques can help in the acquisition, representation and deployment of knowledge about water quality and quantity, particularly in the design and rehabilitation of sewage systems, control and monitoring of water distribution networks, and in the quality management of water supply systems. The Water Industry Expert Systems Club (WIESC) tackles problems relevant to the United Kingdom water industry. WIESC adopted two expert systems, SERPES and WADNES to handle two water quantity problems, namely the rehabilitation of sewer networks, and water distribution networks, respectively. Face-to-face interviews of the experts were used as the principal knowledge elicitation method. Video and audio-tape recorders were used to acquire knowledge and subsequently transcribe and analyze the interviews. Prototyping and paper-modelling techniques proved useful in the knowledge acquisition for the expansion and refinement of the implemented systems. The Quantity and Quality Expert System (Q2X) was used to carry out an initial feasibility study for a water utility responsible for supplying quality water to a large town with a time-varying demand profile. The Q2X system comprised six knowledge-bases: monitor quality, reservoir operations, feed-source use, network management, stored water quality management, and financial management. The simulation and modeling programs required for a full-fledged Q2X include: programs to model algal growth, network analysis programs, nitrate transformation programs, optimization programs for efficiently managing pump schedules and costs, and hydraulic performance analysis programs to manage head losses and secondary filter management. The Algae Prediction Expert System (APRES) was developed to demonstrate how expert systems methods and techniques could help to solve algae management problems in reservoirs. (See also W91-01211) (Geiger-PTT)  
W91-01213

### WATER QUALITY INDEX FOR USE IN THE OPERATIONAL MANAGEMENT OF RIVER WATER QUALITY IN EUROPE.

Middlesex Polytechnic, Enfield (England).  
M. A. House.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York, 1989. p 159-168.

Descriptors: \*Europe, \*Pollution index, \*Regulations, \*Water pollution control, \*Water quality, \*Water quality management, Biochemical oxygen demand, Monitoring, Nitrates, Public health, Rivers, Toxicity, Water quality standards.

The adoption of a water quality indexing system for the operational management of river water quality provides more detailed information than that of a classification system. The theoretical basis underlying the development of a series of four independent water quality indices involves incor-

poration of legal water quality standards and criteria and the inclusion of the information on potential water use and toxic determinands directly within their structural format. The General Water Quality Index (WQI) was developed for application within the routine water quality monitoring programs of the United Kingdom water industry. It has a scale of 10-100 and relates changes in water quality to its suitability for use in a range of possible water uses. The Potable Water Supply Index (PWSI) is based on routinely monitored determinands and reflects changes in water quality in terms of its suitability for use in potable water supply. This is similarly the case for the Potable Sapidity Index (PSI) which is based on less frequently monitored toxic determinands such as heavy metals, pesticides and hydrocarbons. The final index, the Aquatic Toxicity Index (ATI), is also based on toxic determinands and reflects water quality in terms of its ability to support healthy fish and wildlife populations. The continuous scale provided by a water quality index allows changes in river water quality to be highlighted. The sub-division of this scale into four water quality and water use categories contains sufficient flexibility to enable information at both government and public levels. (See also W91-01211) (Geiger-PTT)  
W91-01215

### ECOLOGICAL MONITORING: THE NEED FOR A STANDARD.

Wimpol Ltd., Swindon (England).  
R. M. Pagett.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York, 1989. p 169-176, 1 fig, 14 ref.

Descriptors: \*Benthos, \*Bioindicators, \*Monitoring, \*Water quality standards, Ecology, Mussels, Sampling, Toxicity, Water pollution effects, Water quality.

Studies of benthic organisms as indicators of water quality offer benefits over chemical surveys for determining suitability of bathing water according to EC directives. Monitoring of natural sentinels should give some quantifiable measure of the bio-availability of pollutants and provide a time-integrated value for a given contaminant. When using sentinel organisms such as mussels as bioindicators of pollutants the biological variability of size, age, reproductive condition, gender and seasonality should be considered. Programmable, submersible pump systems incorporating exchange and macro-reticular resins (artificial sentinels) may also be used for in situ concentration of contaminants. Sub-lethal techniques may offer insights into toxicity effects that are otherwise difficult to measure by direct toxicity to benthos. The handbooks produced by the International Biological Programme and the Estuarine and Brackish Water Sciences Association provide a useful digest of present approaches and methodologies for benthic survey work and for various ancillary measurements. Legislative measures should be taken to establish a directive for benthic studies to develop standards in using benthos for water quality testing. (See also W91-01211) (Geiger-PTT)  
W91-01216

### DEVELOPING AN ECONOMIC METHODOLOGY FOR LEGAL PROVISIONS REGULATING GROUNDWATER POLLUTION.

Georgia Univ., Athens. Dept. of Agricultural Economics.  
T. J. Centner.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York, 1989. p 177-186, 1 fig, 21 ref.

Descriptors: \*Groundwater pollution, \*Liability, \*Pesticides, \*Water law, \*Water pollution control, Compensation, Legal aspects, Legislation, Model studies, Negligence.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5G—Water Quality Control

Liability for groundwater pesticide contamination from the application of pesticides is the focus of debate in recent environmental legislation. Two critical questions accompany the issue of compensation for pollution damage: who should bear losses and how to apportion the losses. To minimize costs, persons may reduce their polluting activities if such is less costly than expected liability costs. The liability models reveal that placement of costs influences the adoption of precautions which in turn affects the amount of a polluting activity. Notwithstanding the fact that it is difficult to delineate a preferred response for all types of pollution, the model and factors concerning groundwater contamination suggest that improvements in efficiency can be achieved through changes in existing liability legislation. In the absence of unilateral precaution, strict liability rules may not offer a very efficient solution. Rather, a liability rule based on negligence may be preferable with private rights of action. Comparative negligence may minimize evidentiary uncertainty and respond to risk aversion, although this depends on the symmetry of precaution. The cheapest cost avoider may impact what type of negligence solution is superior. Alternative suggested solutions involve modifying liability rules or employing property rules to modify entitlements. Legislation has been introduced to change from a strict liability standard to negligence for pesticide application pursuant to label instructions by agricultural producers. Comparative negligence may provide a preferred solution. The second category of response is to modify existing entitlements through new legislation. Special cases involving underserving victims, small numbers of victims, high victim protection costs, and asymmetrical transaction costs may justify a property rule that shifts an entitlement to agricultural producers who engage in contamination, with victims protected by a liability rule that would allow them to pay the polluter to reduce pollution. However, given the growing concern about groundwater contamination, unknown risks, and externalities, economic incentives such as tradeable permits or pollution charges should be further considered as a component of legislation to respond to problems of non-point agricultural pollution. (See also W91-01211) (Geiger-PTT) W91-01217

#### WATER QUALITY: THE PUBLIC DIMENSION.

Middlesex Polytechnic, London (England). Flood Hazard Research Centre.  
C. H. Green, M. A. House, A. Burrows, and S. M. Tunstall.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 187-195, 1 fig, 2 tab, 18 ref.

Descriptors: \*Cost-benefit analysis, \*Public opinion, \*Public policy, \*Rivers, \*Water law, \*Water pollution control, \*Water use, Recreation, Water costs, Water quality.

In the simplest terms, investment to improve river water quality is justified if the value the public puts upon these improvements is less than the cost of the improvements. Indirectly, such improvements may benefit the public by, for example, lowering the treatment costs of abstracted water. However, the major direct uses of river corridors by the public are as recreational resources, as amenities and as a 'psychic' resource. The latter value arises out of any desire by the public to preserve landscapes, flora and fauna. To determine the value that the public places on possible water quality improvements, it is necessary to explore the motives which underlie any public preference for clean rivers; and upon what basis the public perceives water quality, how they judge whether or not a river is polluted. At the same time, a river as a recreational and psychic resource cannot be separated from its context: the river corridor. The value of water quality improvement in part depends upon the value of the river corridor. Studies carried out to date indicate that perceived water quality is judged largely by the presence or absence of obvious signs of pollution, and of fish.

Both as a recreational and as a psychic resource river corridors are valued as 'natural' resources: mature landscapes with abundant plants, birds and insect populations and an absence of other visitors are what the people desire of river corridors. (See also W91-01211) (Author's abstract) W91-01218

IS IT POSSIBLE TO REGAIN AN ECOLOGICAL BALANCE IN A LAKE WITH BLOOMS OF NUISANCE MICROORGANISMS.  
National Inst. of Public Health, Oslo (Norway). Dept. of Water and Hygiene.  
For primary bibliographic entry see Field 5C. W91-01220

CLINICAL AND ENVIRONMENTAL EFFECTS OF A MAJOR EMERGENCY INVOLVING PUBLIC WATER SUPPLY.  
Robens Inst. of Industrial and Environmental Health and Safety, Guildford (England). Trace Element Lab.  
A. Taylor.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 277-282, 2 fig, 6 ref.

Descriptors: \*Drinking water, \*Emergency planning, \*Public health, \*Water quality management, \*Water treatment, Future planning, Management planning, Networks, Potable water, Water pollution effects, Water supply.

Incidents involving the contamination of drinking water supplies serve to illustrate that arrangements to handle the situation and ensure public health are ineffective or are too limited in scope. Appropriate thought should be given to: (1) dealing with an immediate problem, (2) enlisting the support of those affected, and (3) ensuring that follow-up is properly initiated to benefit all groups involved. Consideration should be given to work before an emergency with prediction of what disasters could take place, how a service would be affected, and the preparation of plans to maintain supplies. Procedures to be adopted in response to an emergency include: the immediate assessments and decisions that need to be made, the announcements and communications with the public, the collection and distribution of information, an assessment of areas of ignorance, and the collection of specimens, measurements, and contact with other interested organizations and institutions. A task force core group composed of water industry representatives, microbiologists, toxicologists, and secretariats should be assembled to meet with advisors and plan a course of action to prevent water pollution incidents and to solve pollution problems in an organized manner should an emergency arise. (See also W91-01211) (Geiger-PTT) W91-01228

DISINFECTION AND SCREENING OF SEWAGE TO IMPROVE THE QUALITY OF BATHING WATER AT A U.K. SEASIDE RESORT.  
Wessex Scientific Services, Bristol (England). Technical Services.  
For primary bibliographic entry see Field 5D. W91-01233

SHORE-BASED MICROBIOLOGICAL SAMPLING OF RECREATIONAL/BATHING WATERS: POSSIBLE PROBLEMS AND SOLUTIONS.  
Clyde River Purification Board, East Kilbride (Scotland).  
For primary bibliographic entry see Field 5A. W91-01234

VIROLOGICAL QUALITY OF BATHING WATERS IN ENGLAND.  
Severn-Trent Labs., Coventry (England).  
For primary bibliographic entry see Field 5B. W91-01235

#### WATER QUALITY STANDARDS FOR BACTERIOPHAGES.

Rijksinstituut voor de Volksgezondheid in Milieuhygiene, Bilthoven (Netherlands).  
A. H. Havelaar, and M. van Olphen.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 357-366, 2 tab, 16 ref.

Descriptors: \*Bacteriophage, \*Bioindicators, \*Enteroviruses, \*Pollutant identification, \*Water quality standards, \*Water treatment, Chlorination, Coliforms, Disinfection, Ultraviolet radiation, Wastewater treatment.

Waterborne transmission of viruses is now an established fact, and particularly relevant for several viruses causing gastro-enteritis and infectious hepatitis. Water treatment processes must therefore be designed for adequate virus removal. Direct enumeration of relevant viruses is hampered by technical problems, and reliance is based primarily on culturable enteric viruses which can only be assayed in specialized laboratories and in small series. Bacteriophages offer prospects as routinely applicable model organisms. F-specific RNA (FRNA) bacteriophages are proposed as model viruses for process control because effluent chlorination has little effect on these organisms. In addition the FRNA-phages f2 and MS2 are at least as resistant to UV-radiation used in wastewater treatment processes as the human enteric viruses and more resistant than E. coli. FRNA-phages are sewage indicators rather than indicators of pollution by human excreta. In sewage-polluted environments, a relatively constant ratio of FRNA-phages to culturable enteric viruses of 1000:1 is found. More insight in the ecology of the FRNA-phages is needed before general water quality standards can be formulated. (See also W91-01211) (Author's abstract) W91-01238

#### INDUSTRIAL EFFLUENTS: MINIMIZING ENVIRONMENTAL IMPACT.

Watson Hawksley, High Wycombe (England).  
For primary bibliographic entry see Field 5D. W91-01246

#### AGRICULTURE: A POSITIVE CONTRIBUTION TO WATER QUALITY.

Imperial Chemical Industries Ltd., Billingham (England).  
A. J. Williams, and B. Livesey.  
IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York. 1989. p 455-462, 6 fig, 4 tab, 3 ref.

Descriptors: \*Agricultural chemicals, \*Crop production, \*Fertilizers, \*Leaching, \*Nitrates, \*Non-point pollution sources, \*Water pollution control, \*Water pollution sources, Cereal crops, Cultivation, Manure, Nitrogen, Path of pollutants, Soil contamination, Water quality.

Agricultural land is the major water catchment surface. The intensiveness of the farming practiced influences the nitrate content of both ground and surface water. Recent studies show that the majority of nitrate leached from soil comes not directly from fertilizers but is derived from soil organic matter and the quality of nitrate lost is largely a function of land use. Rotations of crops can be adjusted to give the maximum amount of crop cover. Early sown winter cereals will allow less nitrate loss than spring cereals where the land is likely to be uncropped over the autumn and winter. Crops should be fertilized for a realistic yield so that excess fertilizers are not applied to the soil. Fertilization schedules should be decided upon a field-by-field basis, rather than on a district or whole-farm basis, and the quantity of fertilizer nitrogen should take full account of the quantity of nitrogen available from the soil. A high standard of general crop husbandry should be achieved. Nitrogen fertilizers should not be applied in the autumn

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in most situations. Cereal straw should be incorporated wherever possible as the input of carbon helps to mop up nitrates during the critical autumn and winter period. Fertilizers should be applied when the crop is ready to use the nitrogen. Adjusting the timing of cultivations can help to reduce mineralization. Use of ammonium-containing fertilizers combined with a nitrification inhibitor may help to reduce nitrogen release from fertilizers. Problems associated with excessive stocking rates supported by imported feeding stuffs can only be solved by moving manure or by reducing stock rate. There is a need for Pan European research to measure the impact of improved agronomy on the reduction of nitrate losses. (See also W91-01211) (Geiger-PTT)  
W91-01249

**CONTROL OF NITROGENOUS POLLUTION.** Surrey Univ., Guildford (England). Dept. of Chemical Engineering.  
For primary bibliographic entry see Field 5D.  
W91-01250

**WATER QUALITY MANAGEMENT IN ISTANBUL: CREATING A CLEANER ENVIRONMENT.** Istanbul Water and Sewerage Administration, Turkey.  
A. Damali, H. T. Belek, and D. Orhon.

IN: Watershed 89: The Future for Water Quality in Europe. Volume II. Proceedings of the IAWPRC Conference held in Guildford, UK, 17-20 April, 1989. Pergamon Press, New York, 1989. p 505-514, 6 fig, 4 tab, 7 ref.

Descriptors: \*Turkey, \*Wastewater treatment, \*Water pollution control, \*Water pollution treatment, \*Water quality management, \*Water treatment, Estuaries, Monitoring, Sewerage, Wastewater disposal, Water distribution, Water supply.

Efforts to cleanup environmental pollution problems in Istanbul, Turkey are outlined. Under the Istanbul Water and Sewerage Administration Act Number 2560, the responsibility for pollution control rests with the Istanbul Water and Sewerage Administration. In 1984, this agency undertook the restoration of the Golden Horn estuary which was polluted from untreated discharges of municipal and industrial wastewater. Together with massive relocation of industries and the environmental rearrangement of the shorelines, a new plan was put into action to collect all wastewater generated in this area away from the Golden Horn and channel them to wastewater treatment plants. In stage 2 of the wastewater management plan, two major biological treatment works and outfalls were designed at Kucukcekmece and Tuzla. To reduce industrial discharges, pretreatment conditions were specified in relation to the characteristics of each wastewater collection zone and set limits were imposed on wastewater discharges. To balance water supply with water demand, elaborate schemes involving a number of dams and pipelines under the Bosphorus interconnecting the Asian and the European sides of the city were implemented to provide water for a population of nearly 6 million. In 1987, a Regional Supervisory and Data Acquisition system was planned to monitor and control all the water transmission and distribution facilities within the Greater Istanbul Area. Measures were taken to prohibit all industrial activity with polluting potential in the protection zones defined around surface water resources. (See also W91-01211) (Geiger-PTT)  
W91-01254

**DESORPTION OF ODOR SUBSTANCES FROM WATER BODIES TO THE ATMOSPHERE.**

Hyogo Prefecture Environmental Science Inst., Kobe (Japan).  
M. Tsuji, T. Nakano, and T. Okuno.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2019-2021, August 1990. 2 fig, 3 tab, 7 ref.

Descriptors: \*Desorption, \*Odor control, \*Pollutant identification, \*Wastewater treatment, Air pol-

lution, Ammonia, Dimethyl sulfide, Hydrogen sulfide, Japan, Methylmercaptan, Regulations, Trimethylamine, Water treatment.

The Control of Offensive Odor Law of Japan was established in 1971. Five odor substances were stipulated in the Law. The regulatory standards for odor substances consist of the following three items: (1) Regulation applied at the boundary line of the sites; (2) Regulation at the gas emission facilities; and (3) Regulation for the wastewater. The regulation standards for odor substances on the boundary line were decided according to the odor intensity of 2.5 and 3.5 of a five step scale. A method was developed for the evaluation of odor pollution caused by wastewater. Two standard analytical procedures were applied to the determination of odor substances in water: head space analysis and the purge-trap method. Henry's constants for five odor substances (hydrogen sulfide, methylmercaptan, dimethyl sulfide, ammonia and trimethylamine) were measured at several conditions of pH and equilibrium temperature, and were used for the estimation of odor emissions from wastewater. The concentration of odor substances that include partial dissociated compounds in water can be measured by head space analysis or the purge trap method. Concentrations above the effluent are related to the flux of odor substances from the water phase. (Lantz-PTT)  
W91-01282

**ACID RAIN AND PHOTOCHEMICAL OXIDANTS CONTROL POLICIES IN THE EUROPEAN COMMUNITY: A DECISION ANALYSIS FRAMEWORK.**

Environmental Resources Ltd., London (England).  
S. Bell, K. Raymond, S. Watson, and P. Wenman.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2253-2262, August 1990. 3 fig, 4 tab, 1 ref.

Descriptors: \*Acid rain, \*Decision making, \*Environmental protection, \*Europe, \*Public policy, Air pollution, Cost-benefit analysis, Lakes, Model studies, Ozone, Urban areas.

The methodology and key findings are presented of a study to evaluate costs and benefits of alternative acid rain control strategies to be implemented at a European Community level between 1980 and 2000. The methodology adopted was decision analysis, whose key advantage is an explicit consideration of uncertainty. Benefits predicted under some of the control strategies were found to be significantly greater than those predicted for the 'no control' case, particularly for lakes. Urban environmental quality was only expected to improve greatly under the strategy that specifically targeted urban emissions. Predictions for crops and forests were relatively uncertain due to inadequacies in the measurement and modeling of ozone. (Author's abstract)  
W91-01290

**FIELD EVALUATION OF IN-SITU BIODEGRADATION OF CHLORINATED ETHENES: PART 2, RESULTS OF BIOTRANSFORMATION AND BIOTRANSFORMATION EXPERIMENTS.**

Stanford Univ., CA. Dept. of Civil Engineering.  
L. Semprini, P. V. Roberts, G. D. Hopkins, and P. L. McCarty.  
Ground Water GRWAAP, Vol. 28, No. 5, p 715-727, September/October 1990. 10 fig, 5 tab, 40 ref.  
EPA Contract CR-812220.

Descriptors: \*Biodegradation, \*Biological treatment, \*Chlorinated hydrocarbons, \*Cleanup, \*Fate of pollutants, \*Methane bacteria, \*Site remediation, \*Water pollution treatment, Dichloroethylene, Land disposal, Methane, Oxygen, Trichloroethylene, Vinyl chloride.

Results are presented from a field study that document the in-situ biotransformation of trichloroethylene (TCE), cis-dichloroethylene (cis-DCE), trans-dichloroethylene (trans-DCE), and vinyl chloride (VC) in a saturated, semiconfined aquifer. The enhanced biotransformation was accomplished by stimulating the growth of indigenous methane-oxi-

dizing bacteria (methanotrophs) which transform chlorinated aliphatic compounds by a cometabolic process to stable, nontoxic end products. Experiments were performed in the presence and absence of biostimulation by means of controlled chemical addition, frequent sampling, and quantitative analysis. Biostimulation and biodegradation experiments conducted demonstrated that: (1) A specific class of microorganisms, the methanotrophs which are indigenous to the subsurface environment, can be successfully biostimulated to promote the degradation of certain chlorinated aliphatic compounds; (2) Partial transformation of VC, 90 to 95%; trans DCE, 80 to 90%; cis-DCE, 45 to 55%; and TCE, 20 to 30%, occurred over a relatively short flow path of one to two meters in a field test with fluid residence times of one to two days; (3) The rate of biotransformation was dependent on the structure of the chlorinated organic compounds, with less chlorinated compounds more rapidly transformed; (4) An intermediate transformation product, trans-DCE oxide, was produced and resulted from trans-DCE oxidation, which is consistent with the proposed transformation pathway; and (5) Active utilization of methane in the test zone was required for chlorinated aliphatic biotransformation to occur. Field experiments confirmed the existence of a natural population of methane oxidizers that could be stimulated by introducing methane and oxygen. (Lantz-PTT)  
W91-01299

**SHORT TERM BIOTIC RESPONSE BEFORE AND DURING THE TREATMENT OF AN ACID MINE DRAINAGE WITH SODIUM CARBONATE.**

Q.C. Services, Teton, ID.  
W. D. Skinner, and D. E. Arnold.  
Hydrobiologia HYDRB8, Vol. 199, No. 3, p 229-235, July 31, 1990. 2 fig, 5 tab, 7 ref.

Descriptors: \*Acid mine drainage, \*Acid streams, \*Pennsylvania, \*Sodium carbonate, \*Water pollution effects, \*Water pollution treatment, Aquatic insects, Colonization, Hydrogen ion concentration, Mayflies, Species distribution, Species diversity, Trout.

The lower portion of Upper Three Runs, a woodland stream in central Pennsylvania, receives acid drainage from a strip mine. In 1974, the effect of this input on pH and benthic invertebrates was studied. The same stations were again sampled in 1986 and the mine drainage was then treated with sodium carbonate for seven days in an effort to evaluate the short term colonization response of brook trout (*Salvelinus fontinalis*) and invertebrates. No differences in the pattern of pH and invertebrate distribution was found between the 1974 and 1986 results, although pH values and invertebrate densities were higher in 1986. Total number of invertebrates and number of taxa colonizing bricks during three pre-treatment time periods (8, 10, 18 days) did not differ from the single treatment period (7 days). However, two species of Baetis (Ephemeroptera: Baetidae) did increase in the treatment section during sodium carbonate application. The number of brook trout also increased in the treatment section, as compared to one pre-treatment estimate. These results indicate that motile species are able to respond within seven days, whereas, longer treatment may be required to produce community wide responses. (Author's abstract)  
W91-01358

**WHAT SHOULD BE DONE TO MITIGATE GROUNDWATER CONTAMINATION.**

Academy of Natural Sciences of Philadelphia, PA.  
R. Patrick.  
Environmental Health Perspectives EVHPAZ, Vol. 86, p 239-243, June 1990. 9 ref.

Descriptors: \*Environmental protection, \*Fate of pollutants, \*Groundwater pollution, \*Path of pollutants, \*Policy making, \*Water pollution control, \*Water pollution prevention, \*Water pollution treatment, Environmental policy, Hazardous wastes, Management planning, Public health, Public policy, Technology, Waste containment.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5G—Water Quality Control

Groundwater contamination is a serious problem that is growing in the US, but its true extent is not known and it is difficult to determine because of the complexities of contaminants, their transformation, and fate in groundwater systems. It is also difficult to predict their movement in groundwater. Since it is known that the problem is serious and that the need for groundwater will grow, the mitigation of groundwater contamination, despite its high cost, is necessary. Furthermore, it is difficult to predict effects on human health because they have not been defined for many of the chemicals. Antagonism and synergistic effects of interacting chemicals have not been determined because they are complicated by many factors, such as volatile compounds. The effects of leachates in groundwaters entering streams on the riverine environment and aquatic life have not been determined. Successful mitigation requires: (1) determining which microbial and chemical contaminants are the most serious threat to human health; (2) developing the technology to biologically, chemically and physically transform hazardous waste into nonhazardous materials; (3) developing the technology to properly contain hazardous materials; and (4) developing the technology to remediate contamination and determine the effects of those hazardous materials on soils and water microorganisms and macroorganisms. The challenge is how to immobilize or destroy groundwater contaminants so that they will not enter groundwater, or if they enter groundwater, are confined and destroyed. (Author's abstract)

W91-01374

#### SOME PUBLIC ATTITUDES ABOUT HEALTH AND THE ENVIRONMENT.

Roper Organization, Inc., New York.  
For primary bibliographic entry see Field 6B.  
W91-01377

#### SITE SEWAGE DISPOSAL: THE IMPORTANCE OF THE WET SEASON WATER TABLE.

Illinois Univ., Urbana. Dept. of Agronomy.  
For primary bibliographic entry see Field 5E.  
W91-01379

#### WETLAND IDENTIFICATION: A MEANS TO PREVENT POTENTIAL PUBLIC HEALTH PROBLEMS.

Enviram Environmental Consultants, Middlesex, NJ.  
For primary bibliographic entry see Field 2H.  
W91-01380

#### BUFFERING CAPACITY OF COAL MINE SPOILS AND FLY ASH AS A FACTOR IN THE PROTECTION OF THE AQUATIC ENVIRONMENT.

Polish Academy of Sciences, Zabrze. Inst. of Environmental Engineering.  
I. Twardowska.  
Science of the Total Environment STENDL. Vol. 91, p 177-189, February 1990. 4 fig, 2 tab, 14 ref.

Descriptors: \*Acid mine drainage, \*Aquatic environment, \*Buffering, \*Coal mining effects, \*Fly ash, \*Mine wastes, \*Water pollution control, Alkalinity, Buffer capacity, Calcium carbonate, Chemical analysis, Electric powerplants, Hydrogen ion concentration, Industrial wastes, Leachates, Magnesium carbonate, Path of pollutants, Poland, Thermal powerplants, Waste treatment, Water pollution sources.

Carboniferous rocks and colliery spoil samples representing all the stratigraphic series of the coal-bearing formation of the Upper Silesian coal basin (USCB) in Poland, as well as the drainage from the spoil tips were examined with respect to the contamination potential of colliery spoils as a function of the balance between the buffering and acid generation capacities. The susceptibility of spoils and leachates to acidification was estimated experimentally. Coal mine spoils show different buffering rates and compositions of buffering constituents. In general, for the spoils of the USCB, magnesium carbonate concentrations exceed calcium carbon-

ate content in terms of equivalent units. The system is low-buffered and may produce strongly acidic, high sulfate, total dissolved solids and heavy metal drainage if its buffering rate is < 1.5. The buffering rate of freshly-produced spoils is > 2.4 and guarantees the permanent alkaline or neutral reaction of spoils and leachates. Fly ash from coal-fired thermal power stations contains considerable amounts of buffering calcium constituents, which minimize the solubility of neutralization products. Data obtained for representative samples of such fly ash indicate that an effective increase of buffering capacity of low-buffered colliery spoil, and hence a significant abatement of water contamination, could be achieved by means of controlled placing of fly ash layers in the colliery tip during its construction. This has been confirmed by a successful joint deposition of colliery spoil and fly ash over a 16-year period at Przeczlebie in the USCB. (Hoskin-PTT)

W91-01435

#### WILLINGNESS TO PAY FOR GROUNDWATER PROTECTION.

New Hampshire Univ., Durham. Dept. of Resource Economics and Community Development.  
S. D. Shultz, and B. E. Lindsay.  
Water Resources Research WREARQ. Vol. 26, No. 9, p 1869-1875, September 1990. 3 tab, 34 ref.  
New Hampshire Agricultural Experiment Station Project H-337, Scientific 1643.

Descriptors: \*Benefits, \*Groundwater quality, \*Public opinion, \*Water pollution prevention, \*Water quality control, Cost allocation, Economic aspects, New Hampshire, Payment, Public policy, Water policy, Water resources management.

To determine the willingness to pay (WTP) for a hypothetical groundwater protection plan in Dover, New Hampshire, a mail contingent valuation survey was conducted. The median WTP value among Dover residents was estimated to be \$40 per household, and the community WTP value was estimated to be at least \$100,000 annually for a groundwater protection plan. The assessed land values of respondents as well as their incomes were shown to positively influence their WTP values, while their ages had a negative influence on WTP. A variety of other socioeconomic variables, such as respondents assessed house values, the number of years they lived in the community, their knowledge of past groundwater problems and causes, their education, sex, and whether they had children living at home, were shown to have no influence on individuals WTP for groundwater protection. This research illustrates a methodology that other researchers, and water resource managers can use to estimate the value which people place on various water resources and can help to predict whether water policies and projects will be accepted by the public. (Peters-PTT)

W91-01507

#### MULTIDIMENSIONAL SIMULATION APPLIED TO WATER RESOURCES MANAGEMENT.

Universidade Nova de Lisboa (Portugal). Environmental Systems Analysis Group.  
For primary bibliographic entry see Field 6B.  
W91-01508

#### EXPERIENCE IN OPERATING ECOLOGICALLY CLEAN TURBINES.

For primary bibliographic entry see Field 8C.  
W91-01543

#### COASTAL ZONE MANAGEMENT IN BRITISH COLUMBIA: AN INSTITUTIONAL COMPARISON WITH WASHINGTON, OREGON, AND CALIFORNIA.

Simon Fraser Univ., Burnaby (British Columbia). Natural Resource Management Program.  
For primary bibliographic entry see Field 6E.  
W91-01618

#### POISON RUNOFF: NEW ANSWERS TO A PERVERSIVE PROBLEM.

Natural Resources Defense Council, Inc., Washington, DC.  
P. Thompson.

Environmental Forum ENVFEN, Vol. 6, No. 4, p 5-11, July/August 1989. 3 fig.

Descriptors: \*Nonpoint pollution sources, \*Path of pollutants, \*Pollution load, \*Runoff, \*Waste load allocation, \*Water pollution control, \*Water quality management, Administrative regulations, Agricultural runoff, Environmental protection, Management planning, Regulatory agencies, Sediments, United States, Urban runoff, Water quality, Watershed management.

Known for years by the 1972 Clean Water Act title 'nonpoint source pollution', contaminated runoff from farms and urban areas is a dominant source of water pollution. Studies have shown that 65% of river water impairment and 75% of lake water impairment is caused by poisoned runoff from a variety of sources. Sediment is the single largest type of nonpoint source pollution. The barriers to controlling poison runoff include insufficient technical capabilities, the public's failure to perceive the problem, and lack of political resolve to pursue the problem. Recommendations for solving the poison runoff problem require improvement of technical knowledge, increasing public awareness, and implementation of a water quality based approach at the state level. Establishment of total maximum daily load standards for key pollutants provides a goal-oriented framework for implementing best management practices. Model land use and watershed management programs have been initiated by some state and local governments, including 'Load Allocations' for polluted rivers and waterbodies developed by Oregon. It is suggested that the role of the EPA be expanded beyond its present one of technical assistance to enforce a set of minimum criteria by which to judge the adequacy of state programs. (MacKee-PTT)

W91-01623

#### FEDERAL AND STATE ROLES IN ENVIRONMENTAL ENFORCEMENT: A PROPOSAL FOR A MORE EFFECTIVE AND MORE EFFICIENT RELATIONSHIP.

Minnesota State Government, St. Paul.  
H. H. Humphrey, and L. C. Paddock.  
Harvard Environmental Law Review HELRDC, Vol. 14, No. 1, p 7-45, 1990. 186 ref.

Descriptors: \*Environmental protection, \*Federal jurisdiction, \*Legal aspects, \*State jurisdiction, \*Water pollution control, \*Water quality management, Administrative agencies, Enforcement, Institutions, United States.

The allocation of environmental enforcement responsibility between the state and federal government has varied dramatically in different statutory programs enacted over the past twenty years. A significant expansion of the federal role in water pollution control occurred with the passage of the Clean Water Act in 1972. The Safe Drinking Water Act (1982), which regulates the quality of public drinking water systems and the underground injection of contaminants, further expanded federal enforcement authority. Beginning in the mid-1980s, the trend toward federalizing environmental enforcement began to change. The three newest federal environmental programs, the Hazardous and Solid Waste Amendments of 1984 to the Solid Waste Disposal Act, the Emergency Planning and Community Right-to-Know Act of 1986, and the Medical Waste Tracking Act of 1988, all provide for a much stronger state enforcement role. It was recommended that a set of principles for allocating enforcement responsibilities to states and the federal government include the following: (1) States should adopt their own regulatory and enforcement authority to support federal regulatory programs that a state chooses to manage; (2) EPA should ensure a state has developed and has authority to implement a reasonable enforcement strategy before authorizing a state to enforce a federal program; (3) Once a state has been authorized to carry out a federal program, most cases should be handled without EPA inter-

## Water Quality Control—Group 5G

vention; (4) EPA should retain authority to bring enforcement actions in cases involving significant interstate pollution; (5) States should be able to refer certain enforcement cases to EPA; (6) Systems used to account for progress in enforcement should be based on state strategies and designed to encourage innovation by states; and (7) EPA should maintain a credible threat to withdraw authority from states whose implementation of federal programs is consistently inadequate. (MacKeen-PTT)  
W91-01624

# LIABILITY FOR DAMAGES ARISING FROM AN OIL SPILL.

Exxon Co. USA, Houston, TX.  
L. D. Schenke.  
Natural Resources & Environment NRENEL, Vol. 4, No. 4, p 14-16/52-54, Spring 1990.

Descriptors: \*Judicial decisions, \*Legal aspects, \*Liability, \*Oil pollution, \*Oil spills, Administrative agencies, Clean Water Act, Damage, Federal jurisdiction, Legislation, Natural resources, United States.

The Federal Water Pollution Control Act, also known as the Clean Water Act (CWA), provides for the recovery of damages to natural resources in behalf of the public arising from the release of oil. CWA creates liability for certain costs resulting from an oil spill, including damages to natural resources. The natural resource damage provisions of CWA lay dormant until the passage of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as superfund. The recent appellate court decision in Ohio v. Department of Interior (DOI) further complicates a clear definition of liability, but brings the focus back to the statutory language of CWA. Several principles are apparent from that decision itself and earlier cases: restoration must take into account the elements of natural recovery and the restoration must be technically feasible and cost-effective. The government is limited in its recovery to resources that are owned by the public at large, and by the long-standing common law prohibiting double counting. Moreover, the statutory goal is of a compensatory rather than a punitive nature. These are the guidelines, together with the holdings in Ohio v. DOI, that will shape future considerations of this issue by DOI and the courts. (MacKeen-PTT)  
W91-01627

# COMPARATIVE ANALYSIS OF STATE ENVIRONMENTAL POLICY.

Colorado State Univ., Fort Collins. Dept. of Political Science.  
For primary bibliographic entry see Field 6G.  
W91-01630

# CITIZEN ENFORCEMENT OF CLEAN WATER ACT VIOLATIONS; THE SUPREME COURT STEERS A NEW COURSE OVER MUDDIED WATERS; GWALTNEY OF SMITHFIELD, LTD. V. CHESAPEAKE BAY FOUNDATION, INC.

For primary bibliographic entry see Field 6E.  
W91-01634

# INTEGRATION OF LONG-TERM FISH KILL DATA WITH AMBIENT WATER QUALITY MONITORING DATA AND APPLICATION TO WATER QUALITY MANAGEMENT.

Post, Buckley, Schuh and Jernigan, Inc., Columbia, SC.  
For primary bibliographic entry see Field 5C.  
W91-01635

# PROPOSED EPA SLUDGE DISPOSAL REGULATIONS: PROJECT PURGATORY.

BCM Engineers, Inc., Plymouth Meeting, PA.  
For primary bibliographic entry see Field 5E.  
W91-01676

# REGIONAL OVERVIEW OF WATER QUALITY MONITORING.

For primary bibliographic entry see Field 6B.  
W91-01680

# NITRATES IN GROUND WATER.

For primary bibliographic entry see Field 5B.  
W91-01681

# EFFECT OF ENVIRONMENTAL STORAGE CONDITIONS ON THE ORGANIC CONTENT OF SIMULATED COAL LEACHATES.

Maryland Univ., Solomons. Chesapeake Biological Lab.  
N. J. Fendinger, J. C. Radway, and J. H. Tuttle.  
Archives of Environmental Contamination and Toxicology AEECTCV, Vol. 19, No. 2, p 249-256, March/April 1990. 3 fig, 4 tab, 16 ref. Maryland Department of Natural Resources Grant P97-84-04.

Descriptors: \*Biodegradation, \*Coal mines, \*Coal storage, \*Leachates, \*Mine drainage, \*Path of pollutants, \*Water pollution control, \*Water pollution sources, Bacteria, Hydrocarbons, Lime, Organic carbon, Oxygen, Temperature.

Simulated coal leaching experiments were conducted at 25 C and 7 C, after lime treatment, and under reduced oxygen tension. Leachate from coal stored at lower temperatures, reduced oxygen, and higher pH values with lime, had lower conductivities, and lower concentrations of dissolved organic carbon (DOC) and total organic carbon (TOC) than leachates from coal stored at higher temperatures and/or oxygen rich conditions. The leaching of DOC was found to be related to acid production by chemoautotrophic bacteria. Lower concentrations of DOC in leachates from coal treated with lime can be attributed to neutralization, subsequent decreased production of acidity by autotrophic bacteria, and the utilization of DOC by heterotrophic bacteria. Concentrations of aliphatic and aromatic hydrocarbons associated with the liquid fraction of leachates were not influenced by temperature or reduced oxygen concentration. Changes in the aliphatic hydrocarbon content of the coal leachates are related to metabolism by heterotrophic bacteria and/or to decreased acidity. (Author's abstract)  
W91-01689

# GEOTEXTILES AS SEALING LINERS FOR EARTHEN MANURE RESERVOIRS: PART 1, GEOTEXTILE POROSITY.

Macdonald Coll., Ste. Anne de Bellevue (Quebec).  
Dept. of Agricultural Engineering.  
S. F. Barrington, S. O. Prasher, and R. J. Raimondo.  
Journal of Agricultural Engineering Research JAERA2, Vol. 46, No. 2, p 93-103, June 1990. 5 fig, 8 tab, 9 ref.

Descriptors: \*Geotextiles, \*Liners, \*Manure, \*Materials testing, \*Porosity, \*Waste storage, \*Water pollution control, Infiltration, Performance evaluation, Permeability, Pressure head.

The development of an inexpensive but durable sealing liner is required for earthen manure storage facilities built of coarse sand or gravel. Fine porosity geotextiles can be used for this purpose, because manures seal media of small pore size. Non-woven geotextiles of 20, 30 and 40 micrometers in equivalent porosity were subjected to pressure heads of 0.9, 1.8, and 2.7 m of swine slurry for 1800 h. Infiltration rates decreased from 0.05 mm/sec to <0.1 and 0.02 microm/s within 150 and 1000 h, respectively. Although some of the experimental combinations gave significantly higher infiltration rates, all geotextiles demonstrated minimum seepage rates ranging from 1.3 m/s to 1.8 Nm/s after 100 to 1400 h. In all cases, seepages were highly contaminated. Highest chemical oxygen demand levels were observed for the 2.7 m heads as well as the 20 micrometer fabric. This 20 micrometer fabric produced significantly higher infiltration rates, probably because of its lower permeability which encourages a less compact manure seal at its surface. (See also W91-01701) (Author's abstract)  
W91-01700

# GEOTEXTILES AS SEALING LINERS FOR EARTHEN MANURE RESERVOIRS: PART 2, SEALING MECHANISMS.

Macdonald Coll., Ste. Anne de Bellevue (Quebec).  
Dept. of Agricultural Engineering.  
S. F. Barrington, S. O. Prasher, and R. J. Raimondo.  
Journal of Agricultural Engineering Research JAERA2, Vol. 46, No. 2, p 105-112, June 1990. 2 fig, 6 tab, 13 ref.

Descriptors: \*Geotextiles, \*Liners, \*Manure, \*Materials testing, \*Waste storage, \*Water pollution control, Canada, Infiltration, Permeability, Porosity, Solids, Temperature.

Field sealing of geotextile liners for earthen manure reservoirs was verified in the laboratory. A fabric of 20 micrometers in equivalent porosity was subjected to swine slurries of various total solid (TS) levels as well as sterilized and natural 5% TS swine slurries. The infiltration tests indicated that satisfactory clogging of the fine porosity geotextile requires swine slurries of minimum TS content of 4%. Furthermore, higher TS levels guarantee a longer lasting manure seal at the fabric surface. Sterilized manure was used to produce the cool field conditions found in Canada, where manure remains at temperatures of 5-10 C throughout most of the year. Under such conditions biological sealing mechanisms are almost nonexistent. The manure mat retained its impermeability under conditions of sterilization while the natural manure mat demonstrated an increase in infiltration after 1000 h. This gain in manure mat permeability can be attributed to the microbial degradation of manure solids. (See also W91-01700) (Author's abstract)  
W91-01701

# RESPONSES OF PLANKTON AND NUTRIENTS TO METHYLENE BLUE-PHOTOSENSITIZED LAKE RESTORATION.

Nevada Univ., Reno. Dept. of Civil Engineering.  
R. J. Watts, and R. H. French.  
Chemosphere CSMHAF, Vol. 20, No. 6, p 663-671, 1990. 9 fig, 13 ref. U.S. EPA Assistance Agreement R811124-01.

Descriptors: \*Lake restoration, \*Methylene blue, \*Nutrients, \*Photolysis, \*Plankton, \*Water pollution treatment, Algae, Algal blooms, Bacteria, Chlorophyta, Cyanophyta, Diatoms, Eutrophic lakes, Lakes, Nitrogen, Phosphorus, Trophic level, Viruses.

The use of sensitized photolysis has been proposed as an improved lake restoration method. Methylene blue is a sensitizer; in the presence of 500 to 700 nm light it is excited to a triplet state. A primary target of the triplet energy is molecular oxygen, which is excited to singlet oxygen. Singlet oxygen is toxic to bacteria, viruses, and algae, and serves as the basis for treating algal blooms. Sections of eutrophic Lahontan Reservoir, Nevada were isolated using in situ microcosms and treated with 1.0 mg/L methylene blue to assess its effectiveness for lake restoration. Green algae (Chlorophyta) and diatom (Bacillariophyceae) levels decreased significantly with one day of treatment; however, blue-green algae (Cyanophyta) levels did not decline. Nitrogen and phosphorus concentrations did not increase after photochemical treatment over the 10-day study period. It is concluded that the use of methylene blue for lake restoration may therefore be ineffective in treating blue-green algae, the group which often causes the most problems in eutrophic systems. (Agostine-PTT)  
W91-01736

# SOIL CLEAN UP BY IN-SITU AERATION: V. VAPOR STRIPPING FROM FRACTURED BEDROCK.

Vanderbilt Univ., Nashville, TN. Dept. of Chemistry.  
D. J. Wilson.  
Separation Science and Technology SSTDSS, Vol. 25, No. 3, p 243-262, 1990. 11 fig, 4 tab, 23 ref.

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5G—Water Quality Control

Descriptors: \*Aeration, \*Bedrock, \*Cleanup operations, \*Mathematical models, \*Soil contamination, \*Vapor stripping, \*Water pollution treatment, Diffusion, Model studies, Transport, Ventilation.

A mathematical model for soil vapor stripping is presented which permits one to model vapor stripping from porous fractured bedrock, where one cannot make the assumption of local equilibrium between the stationary condensed phase and the moving vapor phase with respect to contaminant transport. Models for lab column operation and field operation of a vapor stripping well are presented. A lumped parameter approach is used to handle the kinetics of diffusion of the volatile contaminant from the interiors of the bedrock out to the moving soil gas. A method for estimating the time constant for this diffusion transport is presented and the effects of the time constant on the performance of vapor stripping operations are assessed. Increasing the diffusion time constant results in reduced removal rates. The effects of impermeable circular caps on vapor stripping wells with and without passive vent wells are examined. A moderate improvement in contaminant removal rate with increasing cap radius is seen in systems without passive vent wells. In the absence of a cap the presence of passive wells decreases the contaminant removal rate. In the presence of a cap the presence of passive wells increases the removal rate by 20%. These results suggest that the use of passive wells when one is vapor stripping underneath impermeable surfaces may be moderately advantageous. (See also W90-1832) (Agostine-PTT)  
W91-01756

#### WELL LOCATION IN CAPTURE ZONE DESIGN USING SIMULATION AND OPTIMIZATION TECHNIQUES.

Connecticut Univ., Storrs. Environmental Research Inst.  
D. P. Ahlfeld, and C. S. Sawyer.  
Ground Water GRWAAP, Vol. 28, No. 4, p 507-512, July/August 1990. 6 fig, 1 tab, 12 ref.

Descriptors: \*Flow models, \*Groundwater pollution, \*Model studies, \*Site remediation, \*Water pollution treatment, Aquifers, Cleanup, Costs, Economic aspects, Linear programming, Pump wells.

The utility of a groundwater simulation model in combination with numerical optimization to provide guidance for proper siting of extraction wells for aquifer remediation was examined. By mathematically defining design criteria, the analyst can directly determine the pump locations and pumping rates which minimize the operational cost of the remediation system. By varying the parameters of the optimization model and comparing the resulting solutions, inferences can be drawn about aspects of remediation. For an example problem, providing greater choice of the location of the wells produced a 37% reduction in pumping cost. Careful selection of well position in an aquifer cleanup can make a major difference in the total pumping cost when considering containment of the contaminant and subsequent cleanup. (Author's abstract)  
W91-01778

#### NATURAL BIOREMEDIATION OF ORGANIC CONTAMINANTS IN GROUND WATER: CLIFFS-DOW SUPERFUND SITE.

Dow Chemical Co., Midland, MI. Environmental Sciences Research Lab.  
For primary bibliographic entry see Field 5B.  
W91-01782

#### GROUND-SURFACE DELINEATION OF FRACTURES OVER MINED-OUT OPENINGS USING CARBON DIOXIDE EMISSIONS.

Idaho Univ., Moscow. Coll. of Mines and Earth Resources.  
F. E. Kirschner, R. E. Williams, and D. R. Ralston.  
Ground Water GRWAAP, Vol. 28, No. 4, p 576-583, July/August 1990. 7 fig, 1 tab, 35 ref. Bureau of Mines Cooperative Agreement No. CO278001.

Descriptors: \*Acid mine drainage, \*Carbon dioxide, \*Geologic fractures, \*Groundwater flow, \*Groundwater recharge, \*Grouting, \*Water pollution control, \*Water pollution sources, Path of pollutants, Soil gases.

Subsurface conduits or zones of hydrogeologic discontinuities that connect mined-out areas in the subsurface through the unsaturated zone to the ground surface of the study area of the Bunker Hill Mine located in Kellogg, Idaho, are amenable to detection by the probe extracted static grab sample/onsite analysis method when the appropriate conditions exist. The method is: cost effective; time-efficient; noninvasive; relatively precise; and relatively easy to use. Four discrete CO<sub>2</sub> anomalies are interpreted to identify four structurally created pathways for groundwater recharge. The high CO<sub>2</sub> concentration zone that is associated with the mappable fault appears to be discrete even though the hanging wall of this fault is a fracture zone, not an absolute plane. The area must be capped or otherwise treated and selective grouting is not justifiable for infiltration control. (Miller-PTT)  
W91-01787

#### FIELD EVALUATION OF IN-SITU BIODEGRADATION OF CHLORINATED ETHENES: PART I. METHODOLOGY AND FIELD SITE CHARACTERIZATION.

Stanford Univ., CA. Dept. of Civil Engineering.  
P. V. Roberts, G. D. Hopkins, D. M. Mackay, and L. Semprini.  
Ground Water GRWAAP, Vol. 28, No. 4, p 591-604, July/August 1990. 12 fig, 6 tab, 29 ref. EPA Cooperative Agreement No. CR-812220.

Descriptors: \*Biodegradation, \*Chlorinated hydrocarbons, \*Field tests, \*Groundwater pollution, \*In situ treatment, \*Site remediation, \*Tracers, \*Water pollution treatment, Aquifers, Automation, California, Chlorinated ethenes, Data acquisition, Military reservations, Mountainview, On-site data collections, Organic solvents, Water pollution abatement.

The conditions at the Moffet Naval Air Station, Mountainview, California site proved to be favorable for a quantitative evaluation of in-situ aquifer restoration by enhanced biodegradation. Bromide tracer tests revealed travel times of 8 to 27 hours from the injection well to the various monitoring wells and 20 to 42 hours from the injection well to the extraction well. Complete breakthrough of the tracer at the monitoring wells was facilitated by choosing a line of wells aligned with the regional flow and selecting injection and extraction flow rates of approximately 1.5 and 10 liters/min. Transport studies were conducted with selected halogenated organic compounds. The retardation factors ranged from 2 to 12. The breakthrough responses for the more strongly absorbing compounds, e.g. trichloroethylene, exhibited pronounced tailing, such that a minimum period of several weeks was required to achieve complete saturation of the aquifer. The microcomputer-driven sampling, analysis and data management system provided automated data acquisition at sample intervals of 40 minutes with coefficients of variation smaller than 20% and allowed for real-time surveillance of the dynamic responses. (Author's abstract)  
W91-01789

#### DECREASING CHLORIDE TRENDS OBSERVED AT LAKE ERIE MUNICIPAL WATER INTAKES.

Lake County Dept. of Health, Waukegan, IL.  
R. S. Whyte, J. H. Hartig, and G. J. Hopkins.  
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 233-240, 1990. 2 fig, 3 tab, 22 ref.

Descriptors: \*Chlorides, \*Lake Erie, \*Pollution load, \*Statistical analysis, \*Water pollution control, Time series analysis.

Using available chloride data collected from seven municipal intakes drawing water from Lake Erie, linear trend analyses were performed to elucidate trends between the late 1960's and the early 1980's. Both seasonality and autocorrelation of the data

were considered. Seasonality did not appear to significantly affect the trend. By removing the effects of autocorrelation more efficient estimates of the regression parameters were obtained and the achieved level of significance was considered valid. A decreasing chloride trend was found for all municipal intakes examined in the study. The rate of chloride decrease ranged from 0.47 to 0.88 mg/L/yr (mean: 0.7 mg/L/yr). This decreasing chloride trend in Lake Erie is believed to be the result of reduced loadings resulting from point source controls and the cessation of certain industrial operations which historically discharged high chloride loadings. (Author's abstract)  
W91-01793

#### EXPERIMENTAL USE OF DIALYSIS CHAMBER ARRAYS TO STUDY P-FLUXES IN THE BAY OF QUINTE, 1987.

National Water Research Inst., Burlington (Ontario).  
For primary bibliographic entry see Field 2H.  
W91-01796

#### VOLATILIZATION OF SELENIUM FROM AGRICULTURAL EVAPORATION POND SEDIMENTS.

California Univ., Riverside. Dept. of Soil and Environmental Sciences.  
U. Karlson, and W. T. Frankenberger.  
Science of the Total Environment STENDL, Vol. 92, p 41-54, March 1990. 3 fig, 4 tab, 27 ref.

Descriptors: \*Biodegradation, \*Decontamination, \*Farm wastes, \*Fate of pollutants, \*Microbial degradation, \*Sediment contamination, \*Selenium, \*Volatility, Agricultural chemicals, Agricultural runoff, Agricultural watersheds, Chitin, Evaporation ponds, Farm ponds, Manure, Microorganisms, Organic carbon, Organic nitrogen, Sediment analysis.

Microbial volatilization of Se was evaluated as a means of detoxifying Se-contaminated sediments. Sediment samples containing 60.7 mg Se/kg (Kesterson Reservoir) and 9.0 mg Se/kg (Peck ponds) were incubated for 273 days in closed systems located in the greenhouse. Various organic and inorganic amendments were tested for their capacity to enhance the microbial process, including Citrus (orange) peel, Vitis (grape) pomace, feedlot manure, barley straw, chitin, pectin, ZnSO<sub>4</sub>, (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>, and an inoculum of *Acremonium falciforme* (an active Se methylating fungus). With the Kesterson sediment, the highest Se removal resulted from the combined application of citrus peel and ZnSO<sub>4</sub>, followed by the citrus peel alone, and citrus peel combined with ZnSO<sub>4</sub>, (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> and A. falciforme. Manure, pectin, chitin, and straw plus N had less pronounced effects. Without the amendments, cumulative Se volatilization was 6.1% of the initial inventory. Grape pomace inhibited the process. With the Peck sediment, the highest amount of Se removed was observed with chitin, manure, and citrus peel alone. Without amendments, 14% of the native Se was volatilized in 273 days. Pectin, straw plus N, and grape pomace were among the less effective amendments for the Peck sediments. The differences in the effectiveness of each treatment between the two seleniferous soils may be a result of the residual N content of the sediments. With the Kesterson sediment, which was high in organic C and N, added N inhibited volatilization of Se, while with Peck sediments (low in organic C and N), N-rich materials tended to accelerate Se volatilization. Inoculation with A. falciforme did not enhance Se evolution from either sediment, indicating that there was a sufficient population of microflora capable of producing gaseous Se. (Author's abstract)  
W91-01814

#### EVALUATION OF DETENTION BASIN PERFORMANCE IN THE PIEDMONT REGION OF NORTH CAROLINA.

North Carolina Univ. at Charlotte. Dept. of Civil Engineering.  
J. S. Wu.  
Available from National Technical Information

## Water Quality Control—Group 5G

Service, Springfield, VA 22161 as PB90-186768/AS. Price codes: A04 in paper copy; A01 in microfiche. North Carolina Water Resources Research Institute, Raleigh, Completion Report No. 248, (UNC-WRRI-89-248), July 1989. 45p, 18 fig, 15 tab, 18 ref. State Project 70077.

Descriptors: \*Detention ponds, \*North Carolina, \*Pollutant identification, \*Storm water, \*Urban runoff, \*Water quality control, Ammonia nitrogen, Copper, Iron, Lead, Metals, Phosphorus compounds, Piedmont region, Sampling, Storm runoff, Suspended solids, Zinc.

Results are summarized of a stormwater sampling program conducted on three existing urban wet detention ponds in the Piedmont region of North Carolina in the city of Charlotte. These ponds were not originally designed for water quality control. A total of eleven storm events was monitored. Runoff samples were analyzed for total suspended solids, total and ortho phosphorus, total Kjeldahl and ammonia nitrogen, and metals of iron, zinc, copper, and lead. The removal efficiency of pollutants for each detention pond was computed as the percent difference of the total pollutant mass entering and leaving the detention pond. An U.S.EPA model was employed to derive a relationship for estimating the size of detention ponds to achieve targeted levels of water quality improvement. It is estimated that about 1.0% to 2.0% of watershed area would be needed for siting of wet detention ponds to accomplish a sediment removal efficiency of 70% or better. The quality of storm runoff from the Piedmont North Carolina urban areas was found to be generally better than that reported by the National Urban Runoff Program. The research findings are consistent with the North Carolina State Government guidelines for sizing wet detention ponds for water quality considerations. Results of this study are based on Piedmont watershed characteristics and should not be applied to other regions without consideration of site specific information. (USGS)

W91-01824

#### EVALUATION OF THE INSTALLATION OF A SEWAGE COLLECTION SYSTEM ON WATER QUALITY IN A PRAIRIE LAKE.

Dakota State Univ., Madison, SD. Coll. of Natural Sciences.  
For primary bibliographic entry see Field 5D.  
W91-01862

#### SAMPLING STRATEGIES FOR PARAMETER ESTIMATION IN GROUNDWATER QUALITY MANAGEMENT: THEORY AND FIELD VALIDATION.

California Univ., Los Angeles. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5A.  
W91-01866

#### ACID PRECIPITATION MONITORING AND RESEARCH. REVIEW OF CURRENT NORWEGIAN ACTIVITIES.

Oslo Univ. (Norway). Dept. of Chemistry.  
G. Taubgol.  
Science of the Total Environment STENDL, Vol. 96, No. 1/2, p 23-43, July 1990. 5 fig, 20 ref.

Descriptors: \*Acid rain, \*Acid rain effects, \*Air pollution, \*Monitoring, \*Norway, \*Reviews, \*Water pollution prevention, \*Water pollution sources, Acid soils, Aluminum, Aquatic animals, Chemical analysis, Ecosystems, Fish populations, Forests, Groundwater pollution, Metals, Nitrogen compounds, Precipitation, Rainfall, Soil contamination.

Acid precipitation is a major threat to Norwegian ecosystems. Politically and administratively, the issue has been given top priority among environmental issues for nearly 20 years. Hence, fairly large resources are spent on monitoring, research activities, reduction measures and local ameliorating countermeasures. During the seventies, a joint interdisciplinary research and monitoring project was carried out to establish basic knowledge of the cause and effect relationships and extent of prob-

lems caused by acid rain. From 1980 onwards the activities were continued within a separate monitoring program which was divided into four major categories: air processes, water, aquatic fauna, and forest and vegetation. The main purpose of the program was to reveal the temporal trends and to assess the geographical distribution of effects. Presently, high priority acid rain projects in Norway include: photo-oxidants and nitrogen compounds, transformation processes and effects, mechanisms for acidification recovery of soils and waters, effects on forest and vegetation, effects of aluminum, and restoration of fish stocks. Norwegian scientists cooperate extensively with groups in other countries and participate in international monitoring networks and research programs. (Author's abstract)

W91-01888

#### ENVIRONMENTAL TESTING-ISSUES AND DIRECTIONS.

D. Friedman, and J. Popplitt.  
Journal of Chromatographic Science JCHSBZ, Vol. 28, No. 9, p 450-452, September 1990. 2 tab.

Descriptors: \*Environmental protection, \*Monitoring, \*Regulations, \*Sampling, \*Testing procedures, Data acquisition, Data interpretation, Laboratory methods, Standards.

The industry of environmental testing is expanding faster than the revisions to the EPA methods manuals are being developed. Changes are occurring in both directions of the testing itself and in the goals of public policy. Environmental decision making rests on the ability to monitor the environment, establish goals, and monitor for compliance with these goals. Because of the complexity of the analytical problems encountered in the hazardous waste program, it has become apparent to the EPA that the system needs to have greater flexibility. Often the analyst encounters matrix or interference problems when trying to measure an analyte of interest. Analysts need to have the flexibility to select the method that is most appropriate to the sample and problem. The lab also needs the freedom to modify methods when standard protocols do not yield data that meets the Data Quality Objective (DQO). (Lantz-PTT)

W91-01913

#### UTILIZATION OF HYDROCARBON SUBSTRATES BY HEAVY OIL-DEGRADING BACTERIA ISOLATED FROM THE SEA WATER OF OIL-POLLUTED BISAN SETO.

Shimonoseki Univ. of Fisheries (Japan). Lab. of Microbiology.  
B. Kimura, M. Murakami, and H. Fujisawa.  
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 56, No. 5, p 771-776, May 1990. 3 fig, 5 tab, 15 ref.

Descriptors: \*Biodegradation, \*Fate of pollutants, \*Hydrocarbons, \*Marine bacteria, \*Oil pollution, \*Water pollution treatment, Bisan Seto, Carbon, Japan, Oil spills, Seawater.

Eighty-one strains of oil-degrading bacteria were isolated from the seawater of Bisan Seto, a polluted Japanese coastal area which had been the site of an oil spill. These bacteria were tested for their ability to grow on four major groups of hydrocarbons—normal alkanes, branched alkanes, cycloalkanes and aromatic hydrocarbons—all known to be present in heavy oils. The hydrocarbon substrates tested were n-hexadecane (as a representative normal alkane), pristane (2, 6, 10, 14-tetramethylpentadecane, as a representative branched alkane), cyclododecane (as a representative cycloalkane), and low molecular weight polycyclic aromatic hydrocarbon mixtures (fluorene plus anthracene plus pyrene). All the bacteria were able to utilize n-hexadecane and pristane, but not cyclododecane and the aromatic hydrocarbons, as a sole carbon source for growth. Using two representative strains of the bacteria, further degradation characteristics were also studied on normal alkanes of different chain length, pristane, and the aromatics. Results suggest that the degradation potential of normal alkanes and branched alkanes is quite high in Bisan Seto, and also that cyclo-alkanes and

polyaromatic hydrocarbons are much more resistant to microbial attack in this area. (Author's abstract)

W91-01945

#### GROUNDWATER TREATMENT WITH ZERO AIR EMISSIONS.

Peroxidation Systems, Inc., Gardena, CA.  
D. A. Cheuvront, C. L. Giggy, C. G. Loven, and G. H. Swett.  
Environmental Progress ENVPDI, Vol. 9, No. 3, p 143-148, August 1990. 3 fig, 13 tab, 11 ref.

Descriptors: \*Air pollution, \*Cleanup operations, \*Groundwater pollution, \*Path of pollutants, \*Volatile organic compounds, \*Water pollution treatment, Activated carbon, Organic pollutants, Ultraviolet radiation.

Air emissions from the treatment of volatile organic compound (VOC)-contaminated groundwater are a growing problem in the United States. When air stripping is used to remove VOCs from contaminated groundwater, contaminants are released into the air causing air pollution problems. Several treatment processes with zero air emissions are available for the decontamination of groundwater. In the liquid phase carbon process, organic contaminated water is percolated through beds of granular activated carbon. The carbon is later regenerated in a fired furnace or is disposed of in a hazardous waste landfill. In air stripping/vapor phase carbon, the organic pollutants are scavenged in the vapor phase usually onto activated carbon which is regenerated either on-site by steam stripping or off-site by furnace. In ultraviolet (UV) chemical oxidation, hydrogen peroxide is used in conjunction with UV light to catalyze the chemical oxidation of organic contaminants in water. This system requires little operator attention and does not produce air emissions. Five case studies relate how the air pollution regulation factors affected the decision for groundwater remediation programs. A southern California aerospace manufacturer chose UV/peroxidation for emissions control in its air stripping operations because of the economic attractiveness of this process and the waiver of permit requirements for UV/peroxidation units. For similar reasons, a northern California fleet refueling facility chose UV peroxidation to cleanup a subsurface spill of leaded gasoline. A northern California industrial facility chose a UV/peroxidation system to handle air stripping discharge from the cleanup of a trichloroethylene plume that was migrating towards a residential area. A New York industry chose UV/peroxidation to help cleanup efforts for a groundwater contaminated with trichloroethylene, vinyl chloride and numerous other industrial solvents. A California industrial facility selected UV peroxidation to comply with regulations to reduce toxicity, mobility and volume of hazardous chemicals at Superfund sites. (Geiger-PTT)

W91-01946

#### MINIMIZATION OF CHROMIUM-CONTAMINATED WASTEWATER AT A PLATING FACILITY IN THE EASTERN UNITED STATES.

Oak Ridge National Lab., TN. Chemical Technology Div.  
For primary bibliographic entry see Field 5D.  
W91-01947

#### BIODEGRADATION OF CHLORINATED HYDROCARBONS IN AN IMMOBILIZED BED REACTOR.

Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.  
For primary bibliographic entry see Field 5D.  
W91-01948

#### PERFORMANCE OF SELECTED IN SITU SOIL DECONTAMINATION TECHNOLOGIES: AN AIR FORCE PERSPECTIVE.

Air Force Engineering and Services Center, Tyndall AFB, FL.  
D. C. Downey, and M. G. Elliott.  
Environmental Progress ENVPDI, Vol. 9, No. 3,

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5G—Water Quality Control

p 169-173, August 1990. 19 ref.

**Descriptors:** \*Biodegradation, \*Cleanup operations, \*Decontamination, \*Groundwater pollution, \*In situ treatment, \*Site remediation, \*Soil contamination, Aeration zone, Monitoring wells, Performance evaluation, Radio waves, Vadose zone.

Soil structure, fuel composition, and the depth at which the release of fuels occurs can affect accessibility of treatment chemicals on hydrocarbon contaminants. When hydrocarbons are released in water-saturated or near-saturated conditions, they form large blobs which are trapped in larger pore spaces with little displacement of water from micropores. Fuels released in drier soils above the water table tend to migrate into micropores and form thin films over soil particles. These residuals may have more limited contact with treatment fluids. Enhanced in situ biodegradation attempts to create favorable aerobic conditions in an environment of heterogeneous soils and delicate geochemical balances. Air Force pilot studies using enhanced in situ biodegradation were conducted at jet fuel spill sites at Kelly and Elgin Air Force Bases. A nutrient and hydrogen peroxide delivery system was designed to test the relative effectiveness of three delivery methods in stimulating biodegradation in the vadose zone and in the groundwater. Two shallow injection wells, infiltration galleries, and a spray irrigation system were installed for a side-by-side comparison. After 18 months of peroxide and nutrient additions, aromatic concentrations in groundwater monitoring wells had decreased from 8 ppm to 200 ppb. However, intense sampling of soils above and beneath the water table did not show a significant removal of soil-bound fuel residuals suggesting that enhanced biodegradation cannot be applied at sites with poor permeability. Results of in situ soil venting tests at Hill Air Force Base showed that venting is very effective in removing large amounts of jet fuel from the soil in a relatively short period of time. Laboratory and field tests using radio-frequency (RF) heating of soil contaminated with jet fuel showed high rates of removal of volatile aliphatic and aromatic compounds from the soil. Use of a state-of-the-art RF generator for full-scale applications could reduce the power input to less than 500 kilowatt-hr/cu yard. Two enhancements to the soil venting process that will be tested in the future are the combination of soil venting and RF heating and the optimization of biodegradation of fuels that occurs during the venting process. (Geiger-PTT) W91-01949

#### DESIGN CONSIDERATIONS FOR SOIL CLEANUP BY SOIL VAPOR EXTRACTION.

ENSR, Acton, MA.  
R. Ball, and S. Wolf.  
Environmental Progress ENVPDI, Vol. 9, No. 3, p 187-189, August 1990. 4 fig, 4 tab, 3 ref.

**Descriptors:** \*Cleanup operations, \*Decontamination, \*In situ treatment, \*Organic pollutants, \*Site remediation, \*Soil contamination, \*Volatile organic compounds, \*Water pollution prevention, Aeration zone, Bioremediation, Design criteria, Groundwater pollution, Oil pollution, Oil spills, Volatility.

A state-of-the-art approach for design and implementation of a soil vapor extraction system to remediate soil at a federal site in the Midwest contaminated with tetrachloroethylene is presented. Soil vapor extraction is performed by applying a vacuum to the soils to induce volatilization of soil contaminants. The extracted air is usually treated for volatile organic compounds (VOC) removal prior to discharge to ambient air. Typical data requirements needed for site characterization and soil vapor extraction system design depend on the size and complexity of the contaminated site. The contaminants must have sufficient volatility, and the soil must have sufficient air permeability for soil vapor extraction to be feasible. In a soil containing both volatile and nonvolatile contaminants, if the nonvolatile fraction is biodegradable and the soil has sufficient air permeability, bioremediation of the nonvolatile fraction may be feasible by inducing subsurface air flow with soil vapor

extraction and by adding nutrients. An integrated systems approach must be taken to remediate a site with contaminated soil and groundwater. The groundwater table is lowered during groundwater pumping and treatment thereby increasing the depth of the unsaturated zone and improving volatilization and capture efficiency of VOCs by soil vapor extraction. At the Midwest site a conceptual model of the subsurface contamination of the soil by tetrachloroethylene (PCE) was developed to design the air extraction and injection well for vapor extraction. In addition, computer analyses of the subsurface airflow induced by the soil vapor extraction process were performed to select optimal locations for the wells. To estimate the remediation time required to achieve the desired cleanup criteria of 1 ppm in the soil, a laboratory column study was performed. The modeled tetrachloroethylene emission rate curve from the laboratory column study was scaled-up to predict the emission rate for a full scale soil vapor extraction system. Actual PCE concentrations in the six monitoring wells agreed well with predicted PCE concentrations from the laboratory model. (Geiger-PTT) W91-01952

#### IN SITU BIODEGRADATION OF TCE CONTAMINATED GROUNDWATER.

ECOVA Corp., Redmond, WA.  
M. J. Nelson, J. V. Kinsella, and T. Montoya.  
Environmental Progress ENVPDI, Vol. 9, No. 3, p 190-196, August 1990. 9 fig, 1 tab, 5 ref.

**Descriptors:** \*Biodegradation, \*Bioremediation, \*Chlorinated hydrocarbons, \*Groundwater pollution, \*In situ treatment, \*Organic solvents, \*Water pollution treatment, Activated carbon, Air stripping, Aquifers, Biological treatment, Fate of pollutants, Microbial degradation, Pseudomonas, Solvents, Trichloroethylene.

Trichloroethylene (TCE)-contaminated groundwater is presently treated by transferring the solvent either to a solid (carbon adsorption) or to the atmosphere (air stripping). Biological treatment of the contaminated water is an alternative that causes complete destruction of the solvent. When performed within the aquifer it is termed in situ biotreatment. A specific strain of bacteria (G4) has been isolated that degrades TCE enzymatically. The process has been extensively tested in the laboratory and confirmed in a field pilot test. The pilot test involved the injection of a clean, oxygenated water stream directly into the TCE plume. Nutrients and G4 were added to the injection stream and TCE and TCE concentrations were measured up and downgradient of the injection well. A decline in TCE levels was observed eight hr after injection and continued for the following ten days. TCE concentrations were reduced from a high of 3,000 parts per billion to a mean value of 78 parts per billion during a 20 day period. (Author's abstract) W91-01953

#### SIMPLE AND RAPID METHOD FOR SCREENING OF HEAVY OIL-DEGRADING BACTERIA FROM MARINE ENVIRONMENT.

Shimonoseki Univ. of Fisheries (Japan). Lab. of Microbiology.  
B. Kimura, M. Murakami, and H. Fujisawa.  
Nippon Suisan Gakkaishi (Bulletin of the Japanese Society of Scientific Fisheries) NSUGAF, Vol. 56, No. 6, p 1009, June 1990. 1 tab, 6 ref.

**Descriptors:** \*Aquatic bacteria, \*Biodegradation, \*Culturing techniques, \*Microbial degradation, \*Water pollution treatment, Fate of pollutants, Membrane processes, Nutrients, Oil spills, Separation techniques.

A rapid method for screening heavy oil-degrading bacteria involves dipping a nitrocellulose membrane filter in a hexane solution containing 2% (weight/volume) desulfurized fuel, evaporating the hexane, and placing the filter at room temperature on the top of 1/5 ZoBell 2216E agar plate on which bacterial colonies are present. After incubation at 25 C for 2 days, the filter is taken out from the agar plate and washed with hot water. Colonies with the ability of oil-degradation make hy-

drophilic spots on the filter which can be easily recognized by visual inspection or microscopic observation if needed. Results of a screening trial showed that among 23 bacterial strains which were isolated following a previously described procedure, 7 isolates demonstrated positive results with the present method. When these bacterial strains were tested for oil degradation determined by gravimetric analysis, all of the positive isolates degraded desulfurized fuel oil, whereas none of the negative isolates did. Besides being rapid and simple, the present method allows the isolation of oil-degrading bacteria even in the presence of organic nutrients other than hydrocarbons, such as peptone or yeast extract, which have been previously regarded as undesirable additives for isolation of oil-degrading bacteria. (Geiger-PTT) W91-01961

#### PREDICTION OF MINE DRAINAGE QUALITY IN PENNSYLVANIA.

Pennsylvania Dept. of Environmental Resources, Harrisburg. Div. of Mine Drainage Control and Reclamation.  
For primary bibliographic entry see Field 5B. W91-01963

#### APPLICATIONS OF ADVANCED MEMBRANE FILTRATION TO INDUSTRIAL WASTEWATER TREATMENT AND GROUNDWATER CLEAN-UP.

Resource Technologies Group, Inc., Morgantown, WV.  
For primary bibliographic entry see Field 5D. W91-01965

#### HISTORIC DEVELOPMENT OF THE CONCENTRATE REGULATIONS.

Stone and Webster Engineering Corp., Fort Lauderdale, FL.  
W. J. Conlon.  
Desalination DSLNAH, Vol. 78, No. 1, p 11-16, July 1990. 1 tab, 4 ref.

**Descriptors:** \*Desalination wastes, \*Florida, \*Regulations, \*Reverse osmosis, \*Waste disposal, \*Water treatment, Desalination, Environmental protection, Governmental interrelations, History, Injection wells, Land application, Membrane processes, Waste characteristics.

Florida has the highest percentage of membrane process plants in the United States. Membrane processes will play an important role as a treatment technology which will assist the water treatment industry to meet present and future drinking water regulations. Perhaps membrane technology will be the best available technology in terms of the greatest organic and inorganic contaminant removal for the amount of capital invested. However, safe methods of concentrate disposal will be necessary, as well as fair and pragmatic regulations concerning disposal, for the application of membrane processes to continue. Information on the characterization of concentrate discharges and deep well injection economics as they relate to all construction will assist the Florida Department of Environmental Regulation (FDER) in its negotiations with EPA on the creation of a separate class of injection wells solely for process concentrate design. A recent rule change to 17-28, Florida Administrative Code (FAC) allows membrane process plants discharging into Class G-III or Class G-IV groundwater to discharge non-hazardous concentrate through land application to aquifers containing greater than 1500 mg/L total dissolved solids. This demonstrates that regulations can be changed for the better through the cooperation of FDER with consultants, utility owners, and other interested parties. Further cooperation may result in additional rule changes and more uniform interpretation of the existing rules and regulations. (Author's abstract) W91-01977

#### CURRENT REGULATORY CONCERNS RELATED TO THE DISPOSAL OF RO CONCENTRATES IN FLORIDA.

## Techniques Of Planning—Group 6A

Florida State Dept. of Environmental Regulation, Tallahassee.

R. S. Dehan.

Desalination DSLNAH, Vol. 78, No. 1, p 17-26, July 1990. 2 fig, 3 tab.

Descriptors: \*Desalination wastes, \*Florida, \*Regulations, \*Reverse osmosis, \*Waste disposal, \*Water quality standards, \*Water treatment, Desalination, Drinking water, Groundwater, Impaired water use, Injection wells, Local governments, Membrane processes.

During adoption of the latest amendments on groundwater regulations affecting reverse osmosis (RO) discharge, the Florida Department of Environmental Regulation (FDER) sought to encourage the use of reverse osmosis as a good way of utilizing groundwater of marginal quality. Chapter 187 of the Florida Statutes, which is the State Comprehensive Plan, lists 14 policies, the very first of which is 'to ensure the safety and quality of drinking water supplies and promote the development of reverse osmosis and desalination technologies for developing water supplies. The groundwater regulation codes, which were developed in 1983, classify groundwater into four classes on the basis of water quality as measured by total dissolved solids and geological confinement. These classes are discussed, as well as water quality standards for groundwater and drinking water standards. Last year FDER amended the secondary drinking water standards as they relate to groundwater and exempted existing facilities from compliance with the secondary standards, but they are still applicable to new facilities. Existing sources and new sources of groundwater discharge are dealt with in different ways in the permitting rules. Regulations concerning desalting with discharge of RO concentrates, such as regulations governing deep well injection of concentrates and construction and operation of underground injection wells are outlined. Arguments from FDER are presented for changing current regulations to reclassify RO concentrate injections wells as municipal rather than industrial, to relieve RO concentrate wells of tubing and packer requirements. (VerNooy-PTT)

W91-0178

#### U. S. FEDERAL HIGHWAY ADMINISTRATION'S RECEIVING WATER IMPACT METHODOLOGY.

Woodward-Clyde Consultants, Oakland, CA.  
E. W. Strecker, E. D. Driscoll, P. E. Shelley, D. R. Gaboury, and J. D. Sartor.

The Science of the Total Environment STENDL, Vol. 93, p 489-498, April 1990. 9 fig, 1 tab, 6 ref.

Descriptors: \*Highway effects, \*Model studies, \*Project planning, \*Risk assessment, \*Storm runoff, Federal jurisdiction, Political aspects, Pollutants, Probabilistic process, Rainfall intensity, Statistical methods, Vollenwieder model, Water pollution, Water quality.

A methodology for assessing the impacts of highway runoff on receiving waters has been developed for Federal Highway Administration (FHWA) for use by state transportation agencies. This methodology is intended to be used as a planning level analysis tool. In cases where there are serious environmental risks which cannot be easily mitigated, a more rigorous approach may be necessary. Included in the design procedure is a lake impact analysis, which uses the Vollenwieder model. The lake analysis does not currently use a probabilistic approach. The interactive Decision Support program that takes the procedure user through the Federal Highway Administration's highway runoff analysis procedure is described. The procedure requires the input of fixed site data, rainfall and streamflow statistics, highway runoff water quality, and target concentrations. The methodology user is provided guidance in entering the required data. Output of the procedure is a return frequency of the exceedances of the target concentration. This methodology is intended for planning level analyses. (Author's abstract)

W91-02000

#### DESIGN AND CONSTRUCTION OF TREATMENT PROCESSES FOR HIGHWAY RUNOFF IN THE FRG.

Ingenieur-Dienst-Nord, Industriestrasse 32, 2806 Oytten, Germany.

For primary bibliographic entry see Field 5D. W91-02001

#### DECONTAMINATION OF HIGHWAY SURFACE RUNOFF IN THE FRG.

Stuttgart Univ. (Germany, F.R.). Inst. fuer Siedlungswasserbau, Wassergute- und Abfallwirtschaft.  
G. Stotz.

The Science of the Total Environment STENDL, Vol. 93, p 507-514, April 1990. 4 tab, 10 ref.

Descriptors: \*Decontamination, \*Detention reservoirs, \*Highway effects, \*Surface runoff, \*Water pollution control, \*Water pollution treatment, \*Water quality management, Effluents, Heavy metals, Suspended solids, Water pollution, Water quality standards.

In order to investigate the possibilities for removing the pollutants originating from motor vehicle traffic that are present in highway surface runoff, the influents and effluents of three detention basins that differed in design and function were analyzed during the years 1978 to 1981. The specific objective of the investigations was to study the elimination of heavy metals and organic substances from the runoff, in order to determine the dimensioning criteria for the construction of treatment facilities. A further objective was to determine the composition of the sludges accumulating in the basins. The investigation of the basins showed that, when properly dimensioned, a detention basin can discharge an effluent in which the concentrations of hazardous substances, originating from motor vehicle traffic, have been reduced by 50 percent to 80 percent through sedimentation and separation processes. Thus, quality requirements for discharges into natural bodies of water can be adhered to. (Author's abstract)

W91-02002

#### POLLUTANT REMOVAL BY GULLY POTS IN DIFFERENT CATCHMENT AREAS.

Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau.

For primary bibliographic entry see Field 5D. W91-02003

#### MACROINVERTEBRATE AND PERIPHYTON RESPONSE TO STREAMBED AGITATION FOR RELEASE OF SUBSTRATE-TRAPPED HYDROCARBONS.

Idaho Univ., Moscow. Dept. of Plant, Soil and Entomological Sciences.

For primary bibliographic entry see Field 5C. W91-02019

## 6. WATER RESOURCES PLANNING

### 6A. Techniques Of Planning

#### BALANCE OF REPRESENTATION IN WATER PLANNING: AN ASSESSMENT OF EXPERIENCE FROM NORTH CAROLINA.

Florida State Univ., Tallahassee. Dept. of Urban and Regional Planning.

B. Stiffl.  
Environmental Science and Technology ESTHAG, Vol. 24, No. 9, p 105-120, September 1990. 3 tab, 34 ref.

Descriptors: \*North Carolina, \*Project planning, \*Public participation, \*Water resources management, Nonpoint pollution sources, Public policy, Public relations, Water pollution control, Water quality control.

Over-representation of private interests and under-representation of public interests has been endemic

in citizen participation in water planning in the USA for many years. Attempts to correct this imbalance in interest representation have not been successful. Such failure is explained by showing that traditional perceptions may not be valid. Empirical evidence from the North Carolina nonpoint pollution control planning program is used. Categories of public and private participants are developed. Agency staff interpretation of representation are reported. Staff believed that private participants were heavily over-represented. The participant categories were tested with staff interpretations tested against participant attitudes. Surprisingly, participant attitudes do not support the staff interpretations. Limitations in traditional categorizations of interests were identified and it was suggested that participants respond to a wide array of incentives and disincentives, not just material rewards. (Author's abstract)

W91-01059

#### RISK PERCEPTION IN INTERNATIONAL RIVER BASIN MANAGEMENT: THE PLATA BASIN EXAMPLE.

Reid, Collins and Associates Ltd., Vancouver (British Columbia).

For primary bibliographic entry see Field 6E. W91-01119

#### ROLE OF ASSET MANAGEMENT.

Water Research Centre, Swindon (England). Asset Management.

R. J. Britton, and P. B. Rumsey.

Journal of the Institution of Water and Environmental Management JIWMMEZ, Vol. 4, No. 3, p 215-255, June 1990. 3 tab, 1 ref.

Descriptors: \*Comprehensive planning, \*Management planning, \*Water conveyance, \*Water treatment facilities, Budgeting, England, Operating policies, Performance evaluation, Projections, Utilities.

Asset management planning has been developed over the last 2 years in response to the needs of the UK water industry as a natural progression from existing engineering planning and accounting practices, to provide more detailed consideration of future investment needs. The six parts of an asset management plan include: procedures for preparing the asset management plan; statement of utility's relevant standards and policies; list of asset systems; information on the performance and condition of principal components of each system; long-term (20-year) investment estimates; and short term (5-year) detailed investment program. In order to achieve and continue to maintain asset management plans, it is necessary to consider the organization and control of the planning functions. Continued re-appraisal of both engineering and accounting objectives is required to ensure a satisfactory result. It is concluded that asset management planning provides an effective method of determining long-term investment needs and is of major benefit in the day-to-day management of a utility. (Author's abstract)

W91-01272

#### HYDROLOGICAL INFORMATION TRANSFER USING HOMS.

Institute of Hydrology, Wallingford (England).

For primary bibliographic entry see Field 7C. W91-01274

#### HYDROGEOLOGICAL DECISION ANALYSIS: 1. A FRAMEWORK.

British Columbia Univ., Vancouver. Dept. of Geological Sciences.

R. A. Freeze, J. Massmann, L. Smith, T. Sperling, and B. James.

Ground Water GRWAAP, Vol. 28, No. 5, p 738-766, September/October 1990. 21 fig, 3 tab, 90 ref, 6 append. NSF Grant CES-8858526.

Descriptors: \*Decision making, \*Engineering, \*Geohydrology, \*Geotechnology, \*Management planning, Cost-benefit analysis, Design standards, Simulation analysis.

## Field 6—WATER RESOURCES PLANNING

### Group 6A—Techniques Of Planning

The first installment of a four part series describes the application of decision analysis to engineering design for projects in which the geohydrological environment plays an important role. The methodology is well suited to the design of contaminant facilities and new waste management facilities, purge-well networks in contaminant remediation applications, or drainage systems in geotechnical projects. The method is based on a risk-based philosophy of engineering design, and involves the coupling of three separate models: a decision model based on risk-cost-benefit objective function, a simulation model for groundwater flow and transport, and an uncertainty model that encompasses both geological uncertainty and parameter uncertainty. The approach can be used for the comparison of alternative engineered components of a system, for the design of monitoring systems, and for the assessment of data worth in design of site investigation programs. This first paper lays the framework; the subsequent papers describe how the methods can be applied in geotechnical and waste management applications. (Author's abstract)

W91-01301

#### DEVELOPMENT OF AN EXPERT SYSTEM EMBEDDING PATTERN RECOGNITION TECHNIQUE FOR GROUNDWATER POLLUTION SOURCE IDENTIFICATION.

California Univ., Davis. Dept. of Civil Engineering.

For primary bibliographic entry see Field 5B. W91-01825

#### SAMPLING STRATEGIES FOR PARAMETER ESTIMATION IN GROUNDWATER QUALITY MANAGEMENT: THEORY AND FIELD VALIDATION.

California Univ., Los Angeles. Dept. of Civil Engineering.

For primary bibliographic entry see Field 5A. W91-01866

### 6B. Evaluation Process

#### ENVIRONMENTAL EVALUATION PROCEDURE FOR COASTAL DEVELOPMENTS IN SOUTH AFRICA.

Cape Town Univ. (South Africa). Environmental Evaluation Unit.

M. R. Sowman.

Ocean & Shoreline Management OSMAR6, Vol. 14, No. 2, p 133-150, 1990. 2 fig, 4 tab, 19 ref.

Descriptors: \*Coastal zone management, \*Decision making, \*Evaluation, \*Public participation, \*Regional development, \*Resources management, \*South Africa, Economic aspects, Human population, Legal aspects, Political aspects, Recreation.

The South African coastline represents an area of intense development pressure. Rapid population growth as well as changing political and socio-economic conditions have resulted in increased demands on coastal land, especially for the development of holiday housing and recreation resorts. Until recently, developers and authorities have encouraged and satisfied these demands without rigorous environmental or developmental constraints. Inevitably, this haphazard and unrestrained approach has led to degradation to coastal resources. The root cause of this is the lack of a formal, structured approach for evaluating the environmental implications of development applications. In response to these problems, a systematic procedure for evaluating the environmental suitability and social desirability of development proposals has been developed to ensure that environmental considerations are routinely integrated into the planning, development and decision-making process; the right questions are asked; the developer becomes more involved with, and responsible for, the development proposal; the public are involved in the planning and decision-making process; costly delays are reduced; applications are processed more efficiently; and the process of decision-taking is improved. (Brunone-PTT)

W91-01122

#### APPLICATION OF THE HSPF MODEL TO WATER MANAGEMENT IN AFRICA.

University of the Pacific, Stockton, CA. School of Engineering.

R. C. Johanson.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 102-109, 13 fig, 5 ref.

Descriptors: \*Hydrological Simulation Program-Fortran, \*Model studies, \*South Africa, \*Water management, \*Water quality, Computer models, Management planning, Mgeni Basin, Rural areas, Simulation analysis, Water quality management.

The Hydrological Simulation Program-Fortran (HSPF), performs a deterministic simulation of hydrology and water quality, for watersheds of arbitrary complexity. Like any such model, HSPF requires calibration data. Thus, most applications (especially for water quality) have been in North America and Europe. However, HSPF was recently applied to two catchments in S. Africa. One was small (90 ha) and highly urbanized; the other was much larger (300 sq km) and rural. The results of simulations involving hydrology, sediment and phosphorus were very satisfactory. Therefore, this type of modeling will be continued in South Africa, with the goal being to help manage water and constituent cycling in the larger Mgeni basin (approximately 4000 sq km), which serves as the water supply and effluent conduit for several rapidly expanding urban centers, as well as numerous rural villages. The use of the HSPF model in sub-catchments of the Mgeni catchment gave local practitioners some valuable experience in using a comprehensive model; the ease with which time series could be stored and processed and the versatility of the model were readily accepted. However, efficient use of the model requires considerable effort in becoming acquainted with the modeling approach, data management techniques, etc. (See also W91-01188) (Lantz-PTT)

W91-01199

#### SOME PUBLIC ATTITUDES ABOUT HEALTH AND THE ENVIRONMENT.

Roper Organization, Inc., New York.

R. H. Baxter.

Environmental Health Perspectives EVHPAZ, Vol. 86, p 261-269, June 1990. 13 tab.

Descriptors: \*Environmental protection, \*Public health, \*Public opinion, \*Surveys, Data interpretation, Public rights, Regulations.

Public opinion is formed both by long-term developments and by single unanticipated events. This suggests that readers of opinion survey findings should note field interviewing dates and further determine what the news media have been reporting about relevant developments and events. Personal health and the cost of health care are high on the public's agenda; this is an important backdrop for any review of public attitudes and priorities related to health and the environment. Americans increasingly believe that they are not spending enough on environmental protection and improvement. Surveys have shown that the more people perceive an environmental threat to their safety, well being and health, the more they will want regulation or industry action to meet the threat. There is high public concern over hazardous waste disposal and the transport and use of toxic materials in manufacturing and processing, industrial accidents involving release of pollutants, the leakage of chemical waste into the soil, and the pollution of water and air from industrial sources. Data collected supports the assumption that for the foreseeable future these and certain other ecological dangers will be seen as serious by large majorities of Americans. (Lantz-PTT)

W91-01377

#### MULTIDIMENSIONAL SIMULATION APPLIED TO WATER RESOURCES MANAGEMENT.

Universidade Nova de Lisboa (Portugal). Environmental Systems Analysis Group.

A. S. Camara, F. C. Ferreira, D. P. Loucks, and

M. J. Seixas.

Water Resources Research WRERAQ, Vol. 26, No. 9, p 1877-1886, September 1990. 11 fig, 5 tab, 36 ref.

Descriptors: \*Cleanup, \*Decision making, \*Fate of pollutants, \*Model studies, \*Oil spills, \*Planning, \*Project planning, \*Water resources management, Mathematical models, Simulation.

A framework for an integrated decision aiding simulations (IDEAS) methodology using numerical, linguistic, and pictorial entities and operations has been developed. IDEAS relies upon traditional numerical formulations, logical rules to handle linguistic entities with linguistic values, and a set of pictorial operations. Pictorial entities are defined by their shape, size, color, and position. Pictorial operators include reproduction (copy of a pictorial entity), mutation (expansion, rotation, translation, change in color), fertile encounters (intersection, reunion), and sterile encounters (absorption). Interaction between numerical, linguistic, and pictorial entities is handled through logical rules or a simplified vector calculus operation. This approach is shown to be applicable to various environmental and water resources management analyses using a model to assess the fate and impacts of an oil spill. Future developments include the implementation of IDEAS implementation on parallel processing machines. (Author's abstract)

W91-01508

#### DEMAND-BASED BENEFIT-COST MODEL OF PARTICIPATION IN WATER PROJECT.

Arizona Univ., Tucson. Dept. of Economics.

For primary bibliographic entry see Field 6D. W91-01511

#### INFRASTRUCTURE-WEATHERING A BOOM-AND-BUST DEVELOPMENT CYCLE.

Austin Water and Wastewater Utility, TX.

T. F. Ellison, and T. M. Walski.

Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 652-664, September/October 1990. 2 fig, 3 ref.

Descriptors: \*Metropolitan water management, \*Nonstructural alternatives, \*Public utility districts, \*Urban planning, \*Wastewater facilities, \*Water resources development, \*Water resources management, \*Water treatment facilities, Environmental effects, Investment, Texas, Water demand, Water rates.

Making wise investments is the goal of every investor. This is certainly true for public utilities as they invest in infrastructure to fulfill their mission of providing safe, reliable, cost-efficient service to their customers. Starting from a capacity deficit condition, the city of Austin, Texas, faced a boom-and-bust development cycle in the 1980s that made sizing and timing decisions for new water and wastewater facilities extremely difficult. Infrastructure and investment decisions were examined for a decade in which Austin experienced a 30% increase in demand, followed by five years of almost no growth. Basic demand-versus-capacity relationships were addressed first. The unusual rates of development activity describe the investment climate. The making of investment decisions was affected by service policies, rate impacts, environmental considerations, and political considerations, including revenue bond voting and the formation of municipal utility districts. Austin's experience calls attention to the importance of certain basic infrastructure planning guidelines, and are lessons learned. (Author's abstract)

W91-01555

#### EVALUATING GROUND-WATER VULNERABILITY TO PESTICIDES.

Woodward-Clyde Consultants, Oakland, CA.

For primary bibliographic entry see Field 5B. W91-01558

#### WATER SUPPLY OR WATER DEFICIENCY.

Duffresne-Henry, Inc., Westford, MA.

**Cost Allocation, Cost Sharing, Pricing/Repayment—Group 6C**

For primary bibliographic entry see Field 6D.  
W91-01562

**AUTOMATING WATER RESOURCE MANAGEMENT.**

For primary bibliographic entry see Field 7B.  
W91-01563

**RESPONSE OF COASTAL ZONE MANAGEMENT PROGRAMS TO SEA LEVEL RISE IN THE UNITED STATES.**

Washington Univ., Seattle. Inst. for Marine Studies.  
P. Klarin, and M. Hershman.  
Coastal Management CZMJBF, Vol. 18, No. 2, p 143-165, 1990. 2 tab, 119 ref.

Descriptors: \*Coastal zone management, \*Environmental policy, \*Global warming, \*Sea level, \*Sea level rise, \*Water resources management, Erosion, Institutions, Land use, Legislation, Management planning, State governments, United States.

State coastal zone management programs are responding to the potential impacts of accelerated sea level rise through a wide range of activities and policies. The federal Coastal Zone Management Act provides a basis for coastal state regulatory activities. State Coastal Zone Management Program (CZMP) responses to concerns about accelerated eustatic sea level rise were classified into four categories: official recognition and assessment of problems and issues; new public and intergovernmental processes; existing adaptable legislation; and new policies responding to sea level rise. Of 24 marine coastal states, 16 were credited with formal recognition of the problem, while only 3 have implemented new policies addressing the issue. Alternative policy responses to sea level rise included zoning restrictions, economic incentives/disincentives, prohibitions or restrictions on development, nonstructural engineering, and groundwater protection policies. Linking sea level rise to more immediate and tangible issues, such as coastal erosion, storm protection, public recreation, and access, provides an opportunity for CZMPs to increase their role in coastal land use policy. Programs that are able to incorporate sea level rise considerations into their overall program objectives will succeed in broadening the scope and range of the planning process. (MacKeen-PTT) W91-01619

**EYE TO EYE WITH HURRICANE GLORIA ON VIRGINIA'S TANGIER ISLAND.**

Old Dominion Univ., Norfolk, VA.  
J. C. Friberg, D. J. Zeigler, and G. K. Fortner.  
Coastal Management CZMJBF, Vol. 18, No. 2, p 167-178, 1990. 2 fig, 3 tab, 30 ref.

Descriptors: \*Coastal zone management, \*Emergency planning, \*Hurricanes, \*Management planning, Chesapeake Bay, Evacuation, Hurricane Gloria, Natural hazards, Surveys, Tangier Island, Virginia.

A field survey on Tangier Island in the Chesapeake Bay and interviews with emergency management officials in Virginia have provided a base on which to assess and interpret the evacuation response of the resident population when threatened by Hurricane Gloria in 1985. Because of their finely tuned cognition of environmental hazards, most islanders responded to an evacuation advisory by leaving the island. The pattern of evacuation response, including choices of evacuation destinations and transit mode off the island, however, indicated a decision-making process that did not conform to the expectations of emergency officials, but betrayed an understanding of human-environment interaction and insights that needs to be incorporated into the emergency planning process. (Author's abstract) W91-01620

**PERMIT REFORM THROUGH COASTAL CONSISTENCY PREVIEW: AN ANALYSIS OF ALASKA'S COORDINATED PROCESS.**

Alaska Univ., Fairbanks.

For primary bibliographic entry see Field 6F.  
W91-01621

**ENVIRONMENTALISM, POLICY FACTORS AND THE COURTS IN NEW ZEALAND.**

Victoria Univ., Wellington (New Zealand).  
For primary bibliographic entry see Field 6E.  
W91-01622

**CALIFORNIAIZATION OF ARIZONA WATER POLITICS.**

W. Parsons, and D. Mathews.  
Natural Resources Journal NRJOAB, Vol. 30, No. 2, p 341-359, 1990. 37 refs.

Descriptors: \*Arizona, \*California, \*Groundwater management, \*Policy making, \*Resources development, \*Water allocation, \*Water policy, Decision making, Institutions, Political aspects, Regional development.

An analysis of Western water policy suggested that an elite core of decision makers establishes the values, determines the agenda and controls the conditions under which water policy is made. The core elite are primarily urban business leaders who guide water resources development as a means of promoting urban growth and development. Semior actors include agriculture, San Diego, and Arizona. The history of Western water policy was seen as being divided into four stages: (1) the foundation of the elites (1880s to 1920s); (2) the rise of the elites (1920s to 1930s); (3) the golden age of concrete (1930s to 1960s); and (4) maintaining elite controls (1970s to present). In the West, a small group of growth and development interests comes to dominate water policy. Furthermore, water policy making in Arizona resembles water policy making as practiced in Southern California, particularly in the continued control of the water agenda. (Author's abstract) W91-01631

**MAR DEL PLATA ACTION PLAN: REVIEW OF PROGRESS OF IMPLEMENTATION IN ASIA AND THE PACIFIC.**

Water Resources Journal, No. 163, p 1-35, December 1989. 20 tab.

Descriptors: \*Developing countries, \*Planning, \*Water conservation, \*Water quality management, \*Water resources development, \*Water supply development, Agricultural water, Conservation, Data acquisition, Data interpretation, Economic aspects, Flood control, Governmental interrelations, Legal aspects, Regional planning, Water pollution control.

The Mar del Plata Action Plan was formulated to help participating countries plan and implement efficient programs for the use, management and conservation of water. In May 1988, the U.N. General Assembly issued a questionnaire to review the overall progress in implementing The Plan, to identify measures to improve U.N. support, and to promote exchange of information among member states. Countries and areas responding as of June 1989 were Australia, Bangladesh, Guam, Hong Kong, India, Indonesia, Japan, Maldives, Myanmar, the Philippines, the Republic of Korea, Samoa, Singapore, Sri Lanka, Thailand and Vanuatu. The survey indicated that most of the countries and areas had a national water policy reflecting the priority attached to water resources development within the national development plans. Problems of renovation of major project structures were experienced or anticipated. Most areas had legislation dealing with ownership and use of surface and groundwater, but felt that it was insufficient or incompatible with development plans. Six countries or areas had multilateral/bilateral agreements for the development of shared water resources. All areas reported networks for climatological and hydrological data collection with varying degrees of adequacy and reliability. Floods are a major concern, although most areas do not have adequate structural or non-structural measures. The survey indicated that constraints in the implementation of agricultural water development programs were due to lack of qualified manpower, shortage of financial resources, institutional deficiencies and lack of equipment. Virtually all reporting countries indicated that multilateral and bilateral cooperation would assist in overcoming constraints. Lack of financial resources was considered the major constraint in the area of research. Most reporting countries and areas were willing to participate in establishing joint regional or subregional organizations or institutions. (Miller-PTT) W91-01679

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**REGIONAL OVERVIEW OF WATER QUALITY MONITORING.**

Water Resources Journal, No. 163, p 95-108, December 1989. 9 tab.

Descriptors: \*Developing countries, \*Planning, \*Regional planning, \*Water quality management, \*Water resources development, Economic aspects, Legal aspects, Water pollution control.

In a survey conducted by the Economic and Social Council for Asia and the Pacific (ESCAP) (1988-89) on water quality monitoring in the region, a total of 31 countries/areas responded, more than twice as many as in a similar survey conducted in 1980, indicating the growing concern and interest in the subject. Almost all countries/areas reported having some programs for monitoring water quality. The results of the analysis are presented, showing the status of legal, institutional and budgetary allocations for control, monitoring and management of water quality. No less than eight countries still did not have any legal instrument or national legislative policy for water quality monitoring and management. Eight other countries reported that existing legislation was inadequate to deal with the problem of pollution. Almost all countries, including Australia and New Zealand, reported that budgetary allocations were not adequate for effective control of water and environmental pollution in their countries. All regional developing countries reported lack of trained manpower, modern technology and equipment. Interest was expressed by all countries or areas in participating in regional seminars or workshops, and also in exchanging information on up-to-date developments in the field of water quality monitoring. (Miller-PTT) W91-01680

**U. S. FEDERAL HIGHWAY ADMINISTRATION'S RECEIVING WATER IMPACT METHODOLOGY.**

Woodward-Clyde Consultants, Oakland, CA.  
For primary bibliographic entry see Field 5G.  
W91-02000

**6C. Cost Allocation, Cost Sharing, Pricing/Repayment**

**LEAKAGE CONTROL IN A UNIVERSALLY METERED DISTRIBUTION SYSTEM: PINE-TOWN WATER'S EXPERIENCE.**

Pinetown Regional Water Services Corp., Natal (South Africa).  
For primary bibliographic entry see Field 3D.  
W91-01270

**WILLINGNESS TO PAY FOR GROUNDWATER PROTECTION.**

New Hampshire Univ., Durham. Dept. of Resource Economics and Community Development.  
For primary bibliographic entry see Field 5G.  
W91-01507

**STRATEGY FOR COST RECOVERY IN THE RURAL WATER SECTOR: A CASE STUDY OF NSUKKA DISTRICT, ANAMBRA STATE, NIGERIA.**

North Carolina Univ. at Chapel Hill.  
D. Whittington, A. Okorafor, A. Okore, and A. McPhail.  
Water Resources Research WRERAQ, Vol. 26, No. 9, p 1899-1913, September 1990. 12 fig, 4 tab, 10 ref.

## Field 6—WATER RESOURCES PLANNING

### Group 6C—Cost Allocation, Cost Sharing, Pricing/Repayment

Descriptors: \*Developing countries, \*Domestic water, \*Economic aspects, \*Nigeria, \*Rural areas, \*Water costs, \*Water use, Cost recovery, Public policy, Social aspects, Water supply development.

In-depth interviews were conducted with 395 households in three rural communities in the Nsukka district of Anambra State, Nigeria, concerning their household water use practices, water expenditures to vendors, willingness to pay for improved water supplies, and household socioeconomic characteristics. Households in Nsukka district do not want to pay for water in advance or commit themselves to a fixed monthly payment for water. They want the freedom to buy water only when they use it, partly due to the seasonal nature of water use and partly because they want control over their cash flow in order to meet other more immediately pressing needs. Equally important, they do not trust government to provide a reliable public water supply. They do not want to pay in advance for a service they are not sure they will ever get. If they are required to pay a fixed fee every month, households are willing to pay only relatively small amounts for improved services, even less than they are currently paying water vendors. Current arrangements for cost recovery, fixed monthly fees for both public taps and unmetered private connections, are inappropriate. Kiosk systems, or kiosk systems with metered private connections for some households, are the most promising way to improve cost recovery and meet consumers' cash flow needs. (Author's abstract) W91-01510

### 6D. Water Demand

#### STEPWISE TIME SERIES REGRESSION PROCEDURE FOR WATER DEMAND MODEL IDENTIFICATION.

Pellissippi International, Inc., Knoxville, TN. S. P. Miaou. Water Resources Research W91-01510, Vol. 26, No. 9, p 1887-1897, September 1990. 1 fig, 8 tab, 22 ref.

Descriptors: \*Model studies, \*Statistical models, \*Water demand, \*Water use, Regression analysis, Time series analysis.

Annual time series water demand has traditionally been studied through multiple linear regression analysis. Four associated model specification problems have long been recognized: (1) the length of the available time series data is relatively short, (2) a large set of candidate explanatory or 'input' variables needs to be considered, (3) input variables can be highly correlated with each other (multicollinearity problem), and (4) model error series are often highly autocorrelated or even nonstationary. A stepwise time series regression identification procedure has been proposed to alleviate these problems. The proposed procedure adopts the sequential input variable selection concept of stepwise regression and a previously published 'three-step' time series model building strategy. Autocorrelated model error is assumed to follow an autoregressive integrated moving average (ARIMA) process. The stepwise selection procedure begins with a univariate time series demand model with no input variables. Subsequently, input variables are selected and inserted into the equation one at a time until the last entered variable is found to be statistically insignificant. The order of insertion is determined by a statistical measure called between-variable partial correlation. This correlation measure is free from the contamination of serial autocorrelation. Three data sets from previous studies (Oklahoma City and Tulsa, OK, and Tucson, AZ) were used to illustrate the proposed procedure. (Author's abstract) W91-01509

#### STRATEGY FOR COST RECOVERY IN THE RURAL WATER SECTOR: A CASE STUDY OF NSUKKA DISTRICT, ANAMBRA STATE, NIGERIA.

North Carolina Univ. at Chapel Hill. For primary bibliographic entry see Field 6C. W91-01510

#### DEMAND-BASED BENEFIT-COST MODEL OF PARTICIPATION IN WATER PROJECT.

Arizona Univ., Tucson. Dept. of Economics. R. B. Billings. Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 593-609, September/October 1990. 1 fig, 5 tab, 42 ref.

Descriptors: \*Cost-benefit analysis, \*Model studies, \*Water demand, \*Water resources development, \*Water use efficiency, Arizona, Rate of return, Regression analysis, Urban planning, Water rates, Water resources management, Water use.

Numerous economists and water resource specialists have advocated the use of demand-based consumer-surplus measures to determine the benefits of possible new water supplies and other water-related projects. This benefits model was estimated for the projected arrival of Central Arizona Project (CAP) water in Tucson, Arizona, using the parameters of a regression-based demand model. The estimated benefits to water users of the anticipated CAP water are \$91 million compared to costs of \$175 million at the 8.625% discount rate currently required for federal projects. Thus direct costs exceed direct benefits by \$84 million over the 100 year life of the project. To keep current water customers from suffering net losses, a payment of \$2,514 in 1985 dollars would be required from each new housing unit over the 100 year life of the project. The internal rate of return for the project is 4.86%, which exceeds the 3.25% rate used in the original analysis of the project. Thus, the practical application has been demonstrated of the frequently-advocated but less frequently-used consumer-surplus model in estimating the benefits of increasing the supply of urban water. (Author's abstract) (Fish-PTT) W91-01551

#### MODELING TO GENERATE RECREATIONAL ALTERNATIVES.

Colorado State Univ., Fort Collins. Water Resources Research Inst. M. Flug, D. G. Fontane, and G. A. Ghoneim. Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 625-638, September/October 1990. 4 fig, 2 tab, 18 ref.

Descriptors: \*Model studies, \*Recreation demand, \*River flow, \*Water resources management, \*Water use, Boating, Dynamic programming, Fishing, Linear programming, Optimization, Watershed management, West Virginia.

Water resource managers are often faced with the task of balancing recreational activities in an attempt to maximize the overall recreational benefits from a river system. Available recreation-use functions for white-water rafting, boating, and fishing as a function of river flow are used to estimate benefits. Optimization models were used to generate alternatives (MGA) that maximize total recreational activities. Monthly river-flow scenarios that produce different mixes of the three recreational activities, yet have essentially the same value of total recreational benefits, were sought. Four MGA methods were evaluated with data for the New River Gorge National River in West Virginia. Two of the MGA methods were based on linear programming, and two were based on dynamic programming. It was found that the MGA methods based on dynamic programming were easier to use and modify. The dynamic programming method provides optimal and alternative solutions over the entire flow range of the New River Gorge. (Author's abstract) W91-01553

#### INFRASTRUCTURE-WEATHERING A BOOM-AND-BUST DEVELOPMENT CYCLE.

Austin Water and Wastewater Utility, TX. For primary bibliographic entry see Field 6B. W91-01555

#### RECONNAISSANCE-LEVEL ALTERNATIVE OPTIMAL GROUND-WATER USE STRATEGIES.

Utah State Univ., Logan. Dept. of Agricultural

and Irrigation Engineering.

R. C. Peralta, and B. Datta. Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 676-692, September/October 1990. 2 fig, 4 tab, 23 ref.

Descriptors: \*Alternative planning, \*Aquifer management, \*Groundwater use, \*Pumping, \*Water resources management, Arkansas, Cropland, Flow control, Groundwater movement, Louisiana, Political aspects, Potentiometric surface, Social aspects, State jurisdiction, Water use.

For any large groundwater use area there are an infinite number of feasible sustainable groundwater withdrawal strategies. Also, there are generally several water management objectives. Alternative explicit planning objectives are: (1) maximize total pumping from the underlying aquifer while causing the evolution of a steady potentiometric surface; and (2) maintain a prespecified target potentiometric surface. Implicit objectives involve controlling stream/aquifer interflow and water flow across a state boundary, and attempting to avoid gross disruption of current cropping patterns. Models, bounds, constraints, and data are formulated. Alternative optimal strategies and the rationale for preferring one strategy were developed for a region in Arkansas. The objective of maintaining the relatively unstressed target potentiometric surface yielded politically and socially unacceptable water use strategies. The most acceptable strategy maximized sustainable groundwater extraction, maintained recent groundwater flow to Louisiana, maintained current potentiometric surface heads at the Louisiana-Arkansas border, maintained more than minimally acceptable surface water flow to Louisiana, and approximately maintained current cropping distributions. Developed planning models utilized the embedding approach, over 300 pumping variables, and 700 total variables, indicating the utility of the embedding method for regional sustained yield (steady-state) planning. (Author's abstract) W91-01557

#### WATER SUPPLY OR WATER DEFICIENCY.

Duffresne-Henry, Inc., Westford, MA. M. L. Wetzel. Water Engineering and Management WENMD2, Vol. 137, No. 8, p 24-26, August 1990. 2 fig.

Descriptors: \*Management planning, \*Water resources management, \*Water supply development.

In the late 1980s, many New England communities experienced water supply shortages that could have been avoided through proper water supply planning and management. While planning will not predict the problems that cause shortages, it will assure that the system is developing new supplies ahead of increased demands and has sufficient capacity to operate in emergency situations. The water supply requirements of a public water system can be predicted by studying past water-use trends in conjunction with detailed planning and zoning data. The two most important trends to evaluate are the maximum day/average day demand ratios and the per service consumption (residential, commercial, industrial, and municipal). Predicting maximum day demand is the most important aspect of water supply planning in order to size groundwater supplies, treatment facilities, pumping equipment, and transmission water mains. The final step in developing water supply projections requires input from the water department, town planning board, and/or local planning agency, to identify potential growth within the existing and future water-system-service areas. Water supply projections should be updated every year, which can be easily performed using a computer. Water supply planning helps provide a safe and adequate supply for both existing and future customers of the water system. Development of new sources requires planning, engineering investigation, regulatory approvals, design, and construction. This process can take several years depending upon the type of supply and treatment facilities required. Therefore, a water department must consider both short-term and long-term solutions for meeting its water supply requirements. (Fish-PTT)

W91-01562

**CHANGES IN WEST AFRICAN SAVANNA AGRICULTURE IN RESPONSE TO GROWING POPULATION AND CONTINUING LOW RAINFALL.**

International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).  
H. I. D. Vierich, and W. A. Stoop.  
Agriculture, Ecosystems and Environment  
AEENDO, Vol. 31, No. 2, p 115-132, June 1990. 4 fig, 4 tab, 42 ref.

Descriptors: \*Agricultural practices, \*Burkina Faso, \*Irrigation practices, \*Land use, \*Rainfall, \*Water conservation, \*Water use, Fertilizers.

Changes in village farming systems, brought about by population growth and continuing low rainfall, are described for the three main agro-ecological zones in Burkina Faso: the Sahel, Sudanian and Guinean zones. The toposequential land use and cropping patterns were used as the basis for a model, which describes the long-term ecological degradation caused by declining proportions of fallow land and over cropping. Several earlier studies have emphasized the flexibility of traditional African agricultural systems. Increasing population pressure and an extended cycle of low rainfall years starting in 1970, have had impacts on farming in Burkina Faso with serious land degradation, particularly for uplands in the Sahelian and North Sudanian zones as a consequence. The Guinean zone, because of its higher rainfall, was less affected, although the same process of fertility depletion and soil crusting of uplands which have caused the serious situation in the north, have also been set in motion in the south. To offset these trends, farmers in all three zones have been introducing more intensive practices (manure and fertilizer use, irrigated gardens, moisture conservation practices) and earlier maturing cereal cultivars. (Lantz-PTT) W91-01683

**SINGLE-STAGE AND TWO-STAGE DECISION MODELING OF THE RECREATIONAL DEMAND FOR WATER.**

Economic Research Service, Washington, DC. Resources and Technology Div.  
L. T. Hansen, and J. A. Hallam.  
Journal of Agricultural Economics Research, Vol. 42, No. 1, p 16-26, Winter 1990. 1 fig, 4 tab, 26 ref.

Descriptors: \*Fisheries, \*Model studies, \*Recreation, \*Water demand, Competing use, Decision making, Fishing, Water supply.

Past rivalry over access to water has usually been between the farmers who irrigate, and new agricultural, industrial and municipal demands. Recently, the recreational demand for water has become another consideration in water allocation decisions. The significance of the recreational demand for water as a fishery resource is examined in this study by applying two different frameworks to the decision to fish recreationally. The consistency of the estimated responses to changes in fishery resources across both decision frameworks testifies to the importance of streams as a recreational fishery resource. Modeling behavior within the household production framework allows all downstream effects to be estimated, not just impacts at particular sites. Marginal values of water as a recreational fishery resource are estimated based on daily values of fishing derived in prior research. (Author's abstract) W91-01699

**SIMULATION OF GROUND-WATER FLOW IN AQUIFERS IN CRETACEOUS ROCKS IN THE CENTRAL COASTAL PLAIN, NORTH CAROLINA.**

Geological Survey, Raleigh, NC. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01843

**SUMMARY OF PUBLIC WATER-SUPPLY WITHDRAWALS AND GEOHYDROLOGIC****DATA FOR THE LOWER CONNECTICUT RIVER VALLEY FROM WINDSOR TO VERNON, VERMONT.**

Geological Survey, Bow, NH. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01845

**6E. Water Law and Institutions****EPA'S PESTICIDES-IN-GROUNDWATER STRATEGY: AGENCY ACTION IN THE FACE OF CONGRESSIONAL INACTION.**

For primary bibliographic entry see Field 5G.  
W91-01094

**CLEAN WATER ACT: A GOOD BEGINNING.**

For primary bibliographic entry see Field 5G.  
W91-01095

**INTEGRATED ANALYSIS OF POLICY OPTIONS FOR PROTECTION OF GROUNDWATER QUALITY.**

Economic Research Service, Washington, DC. Resources and Technology Div.  
For primary bibliographic entry see Field 5G.  
W91-01101

**FEDERAL-STATE TENSIONS IN AUSTRALIAN ENVIRONMENTAL MANAGEMENT: THE WORLD HERITAGE ISSUE.**

Murdoch Univ. (Western Australia). Dept. of Political Science.  
For primary bibliographic entry see Field 6G.  
W91-01102

**QUEENSLAND RAINFOREST AND WETLANDS CONFLICT: AUSTRALIA'S EXTERNAL AFFAIRS POWER-DOMESTIC CONTROL AND INTERNATIONAL CONSERVATION.**

Lewis and Clark Coll., Portland, OR. Northwestern School of Law.  
T. H. Edmonds.  
Environmental Law EVLWAS, Vol. 20, No. 2, p 387-413, 1990. 124 ref.

Descriptors: \*Australia, \*Conservation, \*Environmental protection, \*Federal jurisdiction, \*International law, \*Queensland, \*Rain forests, \*Resource management, \*State jurisdiction, \*Wetlands, Legal aspects, Political aspects, Public participation, Tasmanian Dam decision, United Nations, World Heritage sites.

The federal government of Australia exercised environmental protective power by registering a 3500 square mile Queensland rainforest region with UNESCO's World Heritage Committee and legislating to prevent further timber cutting. This exercise of power sparked a fierce battle between the federal and the State of Queensland governments. The protection, however, is legally valid and met with the popular approval of the Australian electorate. Australia's High Court paved the way for the federal government's successful action with its 1983 Tasmanian Dam decision. This decision authorized the same protective federal legislation as a proper implementation of a treaty, the World Heritage Convention, under the Australian Constitution's external affairs power. The government's exercise of power and the Tasmanian Dam decision are unique because they represent the only worldwide legal test of World Heritage protection. Furthermore, Australia's use of external affairs power to protect the environment is different from United States action, which is so heavily reliant on broadened commercial power. Australia's action provokes observance of the potency of World Heritage protection, and thus elicits questions for future expansion of World Heritage protection of endangered natural areas throughout the world. Australia's example also allows portrayal of World Heritage obligations and possibilities. Australia's action is progressive as a globally emerging nation, and sets an example for other nations faced with internal power struggles to protect the environment. (Author's abstract)

W91-01104

**RISK PERCEPTION IN INTERNATIONAL RIVER BASIN MANAGEMENT: THE PLATA BASIN EXAMPLE.**

Reid, Collins and Associates Ltd., Vancouver (British Columbia).  
J. O. Trevin, and J. C. Day.  
Natural Resources Journal NRJOAB, Vol. 30, No. 1, p 87-105, Winter 1990. 66 ref.

Descriptors: \*International agreements, \*International law, \*International waters, \*Rio de la Plata Basin, \*Risk assessment, \*Watershed management, Argentina, Bolivia, Brazil, Jurisdiction, Paraguay, Political constraints, Relative rights, Rio de la Plata Basin Treaty, Treaties.

Perception of the risk of multilateral cooperation has affected joint international action for the integrated development of the Plata River Basin. The origins of sovereignty concerns among Argentina, Bolivia, Brazil, Paraguay, and Uruguay are explored in terms of their historical roots, which caused rival nations to interpret certain integrating actions as risky. The Plata Basin Treaty is a result of both the common acceptance by all the Plata nations of the mutual advantages of international cooperation in basin development, and of the particular ways in which the treaty provisions allayed the apprehensions of some states. The role of risk in determining the character of the Plata Basin Treaty, and the ways in which risk was managed in order to reach cooperative agreements, are analyzed. The treaty incorporates a number of risk management devices (nonbinding arrangement, the division of the agreement and inclusion of secondary matters, a provision for unilateral denunciation, the unanimity requirement in collective decision making, and an agreement to agree on the ways of implementing future cooperation) that were necessary to achieve international cooperation. The institutional system implemented under the treaty produced few concrete results for almost two decades. Within the current favorable political environment in the basin, however, the structure already in place reopens the possibility of further rapid integrative steps. (Brunone-PTT) W91-01119

**IN RE WATER OF HALLETT CREEK SYSTEM.**

M. Basham.  
Natural Resources Journal NRJOAB, Vol. 30, No. 1, p 187-201, Winter 1990.

Descriptors: \*California, \*Federal jurisdiction, \*Judicial decisions, \*Riparian rights, \*State jurisdiction, \*Water law, \*Water rights, Land tenure, Land use, Legal aspects, Legislation.

In *In re Water of Hallett Creek System* (Hallett Creek), the California Supreme Court held that on federal reserved lands, the United States has state riparian water rights to be used for secondary purposes. The Hallett Creek decision re-opens the question of the impact of the Desert Land Act upon the nonnavigable waters of the West, an issue once thought to be settled by the United States Supreme Court's decision in *Beaver Portland Cement*. In addition, this holding raises the issue of whether the United States may be treated as an ordinary landowner thereby receiving benefits from state law, and, if so, whether subsequent changes in state law can deprive the United States of these benefits. Consequently, the Hallett Creek decision creates more questions than it answers. It remains to be seen how subsequent decisions answer them. (Author's abstract) W91-01120

**MARINE RESERVE MANAGEMENT IN DEVELOPING NATIONS: MIDA CREEK—A CASE STUDY FROM EAST AFRICA.**

Exeter Univ. (England). Dept. of Biological Sciences.

A. D. Kennedy.

Ocean & Shoreline Management OSMAS, Vol. 14, No. 2, p 105-132, 1990. 16 fig, 3 ref, 23 ref.

## Field 6—WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

Descriptors: \*Africa, \*Developing countries, \*Mida Creek, \*Resources management, \*Water pollution, Coastal zone management, Conservation, Environmental protection, Recreation, Tourism, Wildlife.

Mida Creek, part of the longest established marine national reserve in Africa, is used to illustrate contemporary problems facing coastal zone managers in developing nations. Activities performed in the creek by tourists, expatriates and indigenous people are having deleterious effects including pollution, over-exploitation, loss of wildlife and the destruction of natural habitat. Despite management policies designed to protect the creek's resources, considerable overexploitation and associated damage is still occurring. Suggestions are made for improved management techniques, and reconciliation of the conflicting needs of conservation, exploitation and recreation. Despite strong economic pressure, the future of the area lies in the conservation of its biotic resources. To attract tourists, and to continue to provide for the needs of the local people, Mida Creek needs first and foremost to be protected as a reserve for wildlife. (Author's abstract)

W91-01121

#### UNITED STATES V. LARKINS: CONFLICT BETWEEN WETLAND PROTECTION AND AGRICULTURE; EXPLORATION OF THE FARMING EXEMPTION TO THE CLEAN WATER ACTS SECTION 404 PERMIT REQUIREMENTS.

K. E. Varns.  
South Dakota Law Review, Vol. 35, No. 2, p 272-297, 1990. 169 ref.

Descriptors: \*Agricultural runoff, \*Clean Water Act, \*Environmental protection, \*Judicial decisions, \*Permits, \*Water law, \*Wetlands, Agricultural practices, Cultivated area, Drainage effects, Federal jurisdiction.

Section 404 of the Clean Water Act requires a dredge and fill permit whenever dredge or fill material is deposited into any of the 'waters of the United States'. However, the Clean Water Act exempts incidental discharges into 'waters of the United States' resulting from normal, ongoing types of farming activities. United States v. Larkins, presented the Sixth Circuit United States Court of Appeals with the issue of whether the Clean Water Act's farm exemptions applied when the landowners replaced one type of wetland crop with another type of wetland crop, eventually draining and filling the wetland area of his property. The Sixth Circuit held that the farming exemption to section 404's permit requirement is not applicable when a farmer switches from one wetland crop to another thereby causing wetland to be filled. Where an area served primarily wetland functions, even though adjacent to farming activities, the courts have consistently found that if the effect of the change in land use is to convert extensive areas of water into dry land, the conversion is not a 'normal' farming or silviculture activity within the meaning of section 404(f)(1). The court in Larkins followed the same approach in examining the consequences of the landowner's activity. Even though the Larkins used the bottomlands for silviculture and some row crop cultivation prior to draining and filling the land, the court refused to hold that the conversion to dry land fell within the section 404 permit exemption. The holding in Larkins is consistent with the general approach used by other courts and is consonant with Congress' intention that the farming exemption be construed narrowly. (Brunone-PTT)

W91-01123

#### IS THERE A RESERVED WATER RIGHT FOR WILDLIFE ON THE WIND RIVER INDIAN RESERVATION: A CRITICAL ANALYSIS OF THE BIG HORN RIVER GENERAL ADJUDICATION.

D. M. Stanton.  
South Dakota Law Review, Vol. 35, No. 2, p 326-340, 1990. 148 ref.

Descriptors: \*Big Horn River, \*Federal jurisdiction, \*Judicial decisions, \*Reservation doctrine,

\*Water law, \*Water rights, \*Wildlife, Agriculture, History, Indian reservations, Legal aspects, Wildlife habitats, Wyoming.

In *In re the Rights to Use the Water in the Big Horn River* the Supreme Court of Wyoming held that Indian tribes occupying the Wind River Indian reservation and the United States were entitled to an award of reserved water rights quantified solely on the basis of an agricultural purpose for the Indian reservation dating from the time the reservation was created. This note contends that the court erred in failing to follow the Special Master's report wherein wildlife uses were included in the quantification of the reserved water rights award. The Wind River Indian Reservation was reserved from the public domain by the United States as the permanent home of the Eastern Shoshone and Bannock Tribes of Indians by the Second Treaty of Fort Bridger in 1868. Implicit in this reservation was a reserved water right in quantities necessary to fulfill the purposes for which the reservation was created. The 1868 Treaty encouraged agricultural development. However, the Treaty also provided for the use of the reservation as a permanent home for the Tribes, and specifically preserved hunting rights. As the Tribes subsisted on the indigenous wildlife at the time the Treaty was signed, and since both parties contemplated this means of subsistence into the indefinite future, the court should have awarded additional reserved water rights in an amount sufficient to maintain wildlife populations at historic levels on the reservation. (Brunone-PTT)

W91-01124

#### ENVIRONMENTAL IMPACT ASSESSMENT: THE EXAMPLE OF MARINE BIOLOGY AND THE UK POWER INDUSTRY.

Central Electricity Generating Board, Fawley (England). Marine Biological Unit.  
R. N. Bamber.

Marine Pollution Bulletin MPNBAZ, Vol. 21, No. 6, p 270-274, June 1990. 1 fig, 9 ref.

Descriptors: \*Electric power production, \*Environmental impact statement, \*Environmental policy, \*Environmental protection, \*Europe, \*United Kingdom, Ecological effects, Electric powerplants, Regulations, Water resources development.

Environmental impact assessment (EIA) is a process which has been undertaken in some form by the Central Electricity Generating Board in the U.K. for many decades, both as a contribution to public enquiries for consent application and as a natural response to the statutory conditions of the Electricity Act of 1957. The formal title comes from the US originating in the National Environmental Policy Act of 1969. The Commission of the European Communities committed to an official EIA in 1988. The directive became law in July 1988 for any power generating plant with a heat output of 300 MW or more and may be required for smaller plants. The purpose of any single phase of an EIA is to produce the data necessary for the Environmental Statement (ES), which must form a cohesive whole as a procedure of collation, not correction. The ES must make the process of decision easier and meaningful to judges, lawyers, assessors, objectors, and officials. The steps for a biological EIA procedure are: (1) identify the site; (2) determine the fauna and flora, gather the data; (3) identify sensitive or important species or communities; (4) determine the relevant aspects of the development; (5) determine the potential interactions and degree of effect; (6) suggest minimizing or ameliorative procedures; and (7) define post-auditing of monitoring sites. (King-PTT)

W91-01158

#### DEVELOPING AN ECONOMIC METHODOLOGY FOR LEGAL PROVISIONS REGULATING GROUNDWATER POLLUTION.

Georgia Univ., Athens. Dept. of Agricultural Economics.

For primary bibliographic entry see Field 5G. W91-01217

#### WATER QUALITY: THE PUBLIC DIMENSION.

Middlesex Polytechnic, London (England). Flood Hazard Research Centre.  
For primary bibliographic entry see Field 5G. W91-01218

#### WASTES FROM ANIMAL BREEDING: WATER QUALITY STANDARDS IN AN INTEGRATED PERSPECTIVE OF TREATMENT AND VALORIZATION FOR PORTUGAL AND SOUTHERN EUROPE.

Universidade Nova de Lisboa (Portugal). Faculdade de Ciencias e Tecnologia.  
For primary bibliographic entry see Field 5D. W91-01248

#### EXPERT TESTIMONY FOR THE PLAINTIFFS IN THE CASE THAT BROUGHT OHIO GROUND-WATER LAW INTO THE 20TH CENTURY.

Ohio State Univ., Columbus. Dept. of Geology and Mineralogy.  
E. S. Blair, and S. E. Norris.  
Ground Water GRWAAP, Vol. 28, No. 5, p 767-774, September/October 1990. 8 fig, 13 ref.

Descriptors: \*Groundwater management, \*Ohio, \*Water law, \*Water use, Case studies, Competing use, Legal aspects, Water resources management.

The 1984 Ohio Supreme Court ruling on *Cline v. American Aggregates* changed Ohio's groundwater law from an 1861 ruling based on the English Rule of absolute ownership to a doctrine of reasonable use which recognizes that landowners have the privilege to use the water beneath their land, but can be held liable to others if their use of groundwater causes others unreasonable harm. The Ohio Supreme Court did not define unreasonable harm in the *Cline* case. As a result, unreasonable harm is being established through case law, the first such case being the re-litigation of *Cline v. American Aggregates*. Depositions and expert testimony presented during the *Cline* cases, which represent a group of 56 landowners in a single lawsuit, showed the diverse ways in which the quantity and quality of groundwater used for domestic water supplies were affected by operation of a dewatering system at an aggregate mine. The testimony highlighted the complex interaction between regional hydrodynamics, variations in local geohydrologic settings, well construction methods, spatial variations in infiltration and recharge, and vertical leakage with the effects of the regional decline in water levels produced by the dewatering system. The decisions in the *Cline* cases recognized that groundwater is a common resource which needs to be shared and managed for the common benefit of all. The decisions are consistent with changes in groundwater laws in other midwestern states. (Lantz-PTT)

W91-01302

#### SUPPORTING WORLD HYDROLOGY: ACTIVITIES OF INTERNATIONAL HYDROLOGICAL PROGRAMS.

World Meteorological Organization, Geneva (Switzerland). Dept. of Hydrology and Water Resources.

J. C. Rodda.  
EOS EOSTAJ, Vol. 71, No. 30, p 996-997, July 24, 1990. 2 fig, 12 ref.

Descriptors: \*International agreements, \*International hydrological decade, \*Meteorological data, \*Water resources development, Disasters, Forecasting, Foreign research, Hydrologic data, Institutions, Monitoring, Publications.

The 160 member countries of the World Meteorological Organization (WMO) are intimately involved in routinely observing, recording, analyzing, and forecasting the procession of hydrological phenomena (floods, droughts, soil erosion, pollution incidents, landslides, avalanches, river ice formation and breakup) that occur within their territories. These agencies are also involved in water resources assessment. The hydrological services

that perform these tasks face the painstaking recording of events and the utilization of tried and tested methods for prediction and forecasting on a regular basis: standardization of methods, the creation of archives, and the exchange of data. The networks they operate and the data they collect provide the essential ingredient of many research projects. WMO's activities in support of operational hydrology include reports on flood frequency analysis and water quality monitoring; a Guide to Hydrological Practices; Technical Regulations; national testing of suspended sediment samplers, current meters, and water level recorders; an intercomparison of 14 models from 11 countries; and 20 or so technical assistance projects in hydrology. The Commission for Hydrology has agreed upon a program that is being implemented by 32 rapporteurs and working group members, and includes the International Decade for Natural Disaster Reduction and the issues of climate change. Important to most, if not all, of these endeavors is the improvement in the knowledge and understanding of the hydrological cycle. (Fish-PTT) W91-01457

#### COASTAL ZONE MANAGEMENT IN BRITISH COLUMBIA: AN INSTITUTIONAL COMPARISON WITH WASHINGTON, OREGON, AND CALIFORNIA.

Simon Fraser Univ., Burnaby (British Columbia). Natural Resource Management Program. J. C. Day, and D. B. Gamble. Coastal Management CZMJBF, Vol. 18, No. 2, p 115-141, 1990. 1 tab, 66 ref.

Descriptors: \*British Columbia, \*California, \*Canada, \*Coastal zone management, \*Environmental policy, \*Oregon, \*Washington, \*Water resources management, Governmental interrelations, Institutions, Legislation, Local governments, Management planning, Resources development.

The basis for coastal zone management in the United States is established in legislation. In comparison, Canadian federal and provincial governments have adopted a piecemeal approach for managing a variety of concerns examined here: water quality, ecological protection, public access, aesthetics, natural hazards, and water dependency. As a result of this approach, which is characterized by a minimum of federal, provincial, and interjurisdictional coordination, the British Columbia coastal zone is showing signs of stress. For example, major shellfish harvesting areas are being lost to water pollution; ecologically sensitive habitats are being consumed by urban, commercial, and industrial expansion; recreation and tourism opportunities are being impaired by clear cutting and other inappropriate developments; and infrastructure is allowed in flood-prone and erosion-prone areas. Recommendations to improve the approach to coastal management in British Columbia include a variety of innovations. New federal and provincial policies, legislation, institutions, and experimentation with local and regional integrated resource planning are required to better govern the coastal zone. Increased support for existing agencies, public involvement, and access to information as well as more common use of environmental impact studies are needed to justify proposed coastal developments. (Author's abstract) W91-01618

#### ENVIRONMENTALISM, POLICY FACTORS AND THE COURTS IN NEW ZEALAND.

Victoria Univ., Wellington (New Zealand). D. E. Fisher. Environmental and Planning Law Journal EPLJEX, Vol. 6, No. 4, p 316-331, December 1989. 28 ref.

Descriptors: \*Environmental policy, \*Jurisdiction, \*Legal aspects, \*New Zealand, \*Resources management, Administrative agencies, Legislation, Policy making.

Environmentalism, it was suggested, is simply an approach to decision making. This analysis is concerned specifically with the changes that have taken place within the environmental legal system of New Zealand within the last five years. The

Treaty of Waitangi is in form an agreement concluded in 1840 between the Crown and a group of Maori Chiefs guaranteeing the exclusive and undisturbed possession of their lands to the Chiefs and their Tribes. The Treaty of Waitangi is being increasingly recognized as an instrument of legal significance so that at some stage in the future it is likely to be seen as a formal impediment upon the legislative capacity of Parliament. In recent years, Parliament has enacted three major statutes with implications for environmentalism: (1) The Environment Act (1986) establishes the Ministry for the Environment and the Parliamentary Commissioner for the Environment; (2) The State-owned Enterprises Act (1986) provides for the formation, inter alia, of the Coal Corporation of New Zealand Ltd, the Electricity Corporation of New Zealand Ltd, the Land Corporation Ltd, and New Zealand Forestry Corporation Ltd; and (3) The Conservation Act (1987) established the Department of Conservation as a department of government. The New Zealand courts have, either independently of legislation or by the creative use of legislation, treated Maori cultural and spiritual values as matters relevant to environmental management. The significance of environmental perspectives, statutory statements of objective, and policy conflicts between environmental statutes have been practical difficulties faced by the New Zealand environmental legal system. (MacKeen-PTT) W91-01622

#### FEDERAL AND STATE ROLES IN ENVIRONMENTAL ENFORCEMENT: A PROPOSAL FOR A MORE EFFECTIVE AND MORE EFFICIENT RELATIONSHIP.

Minnesota State Government, St. Paul. For primary bibliographic entry see Field 5G. W91-01624

#### LIABILITY FOR DAMAGES ARISING FROM AN OIL SPILL.

Exxon Co. USA, Houston, TX. For primary bibliographic entry see Field 5G. W91-01627

#### ACCOMMODATING FISH AND WILDLIFE INTERESTS UNDER THE FPA.

Gordon, Thomas, Honeywell, Malanca, Peterson and Daheim, Seattle, WA. J. A. Bearzi, and W. R. Wilkerson. Natural Resources & Environment NRENEL, Vol. 4, No. 4, p 20-22, 57-58, Spring 1990.

Descriptors: \*Federal jurisdiction, \*Fish conservation, \*Hydroelectric plants, \*Legislation, \*Licensing, \*Wildlife conservation, Administrative agencies, Legal aspects, Project planning.

The Federal Power Act (FPA), as amended by the Electric Consumers Protection Act of 1986 (ECPA) governs the licensing of hydroelectric projects by the Federal Energy Regulatory Commission (FERC). ECPA has significantly changed the relationships among electric power interests, environmental advocates, fish and wildlife interests, treaty tribes, and state and federal agencies. The new hydroelectric licensing and relicensing process under ECPA illustrates the cycle of Congress responding to pressure by interest groups before judicial solutions fully achieve what these groups seek. The major fish and wildlife provisions of the newly amended FPA require that: (1) the FERC give conservation interests equal consideration with developmental interests in licensing decisions; (2) where the project is within a reservation, the FERC adopt the recommendations of the federal agency managing the reservation; (3) a project must be 'best adapted' to a comprehensive plan for improving or developing a waterway; (4) licence conditions adequately protect, mitigate damages to, and enhance fish and wildlife; and (5) a licensee construct, maintain, and operate at its own expense such fishways as may be prescribed by the Secretary of the Interior or the Secretary of Commerce. The FERC relicensing consultation process consists of three stages: (1) pre-filing consultation; (2) applicant identifies its internal licensing team; and (3) public information forums. Affected tribes must be included in the process from

the outset and be treated as any other government agency. If policy makers cannot resolve their disputes, the consultation process allows the Director of the FERC Office of Hydropower Licensing to do so. It is recommended that applicants utilize every opportunity to settle fish and wildlife issues in pre-filing consultation, in order to avoid the litigation-legislation cycle. (MacKeen-PTT) W91-01628

#### CALIFORNIA V. FERC: STATE REGULATION OF FEDERAL HYDROPOWER.

T. J. P. McHenry, and J. D. Echeverria. Natural Resources & Environment NRENEL, Vol. 4, No. 4, p 26-28, 58-59, Spring 1990.

Descriptors: \*California, \*Federal jurisdiction, \*Hydroelectric plants, \*Judicial decisions, \*State jurisdiction, Administrative agencies, Hydroelectric power, Legal aspects, Legislation, Licensing, Placerville, Project planning, Rock Creek, Water regulation, Water resources development.

On December 4, 1989, the United States Supreme Court granted the state of California's petition for certiorari in a case which will resolve whether the Federal Power Act (FPA) preempts state water regulatory laws or whether Congress intended that hydroelectric projects licensed by the Federal Energy Regulatory Commission (FERC) must comply with the requirements of state water law. The case arises from a hydropower project on Rock Creek, a tributary of the South Fork of the American River located near Placerville, California. The California State Water Resources Control Board (State Board) found that flow rates set by the FERC would greatly reduce the fishery habitat in Rock Creek and adopted permanent higher flow rates. The State of California, acting on behalf of the State Board, has taken the position that federally licensed hydropower projects must comply with state water rights law. The Supreme Court's analysis of the state role in regulating hydropower projects will turn on section 27 of FPA, which has been characterized as an 'anti-preemption provision'. A congressional intent to defer to state regulation of water resources is revealed in the Federal Water Power Act, later incorporated into the FPA. In California v. United States (1978), the requirement for water leases for the protection of fish imposed by the State Board was upheld by the Supreme Court. A Ninth Circuit decision cited FERC's 'comprehensive hydropower planning authority' to support the conclusion that FERC is vested with exclusive jurisdiction over hydropower projects. Oral argument in California v. FERC was scheduled for March 20, 1990, and a decision was expected by the end of the term. (MacKeen-PTT) W91-01629

#### URBAN CAPACITY SHARING: AN INNOVATIVE PROPERTY RIGHT FOR MATURING WATER ECONOMIES.

University of New England, Armidale (Australia). Centre for Water Policy Research.

N. J. Dudley. Natural Resources Journal NRJOAB, Vol. 30, No. 2, p 381-402, 1990. 63 refs.

Descriptors: \*Water allocation, \*Water management, \*Water rights, \*Water supply, Administration, Economic aspects, Urban capacity sharing, Water demand, Water policy, Water users.

Researchers have previously proposed an innovative property right structure for sharing reservoir catchment water between groups of users and, in the case of irrigation farmers, between individual users. The concept is being implemented for sharing between groups. An urban version for individual consumers, urban capacity sharing, has a number of attractive features as an alternative property rights structure. Its introduction would create decentralized demand management with consumers taking the opportunity cost of water into account. It would be as if each user had his own small reservoir on his own small stream. Urban capacity sharing would provide a sound basis for achieving high levels of short and long

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run economic efficiency of water use. Its introduction into urban water economies would be easier and more beneficial if completed early in the water economy maturation process. (Author's abstract) W91-01632

**IN RE RIGHTS TO USE WATER IN THE BIG HORN RIVER 753P.2D76 (WYO. 1988).**  
P. Rogers.  
Natural Resources Journal NRJOAB, Vol. 30, No. 2, p 439-458, 1990. 118 ref.

Descriptors: \*Indian reservations, \*Judicial decisions, \*Legal aspects, \*Water rights, \*Water use, \*Wyoming, Big Horn River, Federal jurisdiction, State jurisdiction, Water law, Wind River Reservation.

In 1977, the State of Wyoming initiated a suit destined to become the first general stream adjudication involving Indian reserved water rights completed under state jurisdiction. In *In re Rights to use Water in the Big Horn River* (Big Horn), decided in February 1988, the Wyoming Supreme Court quantified the reserved water rights of the Shoshone and Arapahoe tribes of the Wind River Reservation in northwestern Wyoming. The decision in Big Horn set the stage for future state adjudications of Indian reserved water rights. The court's strict application of the New Mexico primary purpose test in tandem with its narrow interpretation of the Second Treaty of Fort Bridger departed from accepted principles of federal law. Since the Wind River Reservation is the only Indian reservation in Wyoming, the decision may never be followed. However, other states faced for the first time with complex Indian water adjudications previously within the exclusive jurisdiction of the federal courts may find the Big Horn decision persuasive. If so, the decision may herald a shift away from liberal federal treaty interpretation in the Indian water rights context toward a more restrictive state view, unsupported by existing Supreme Court precedent. (MacKeen-PTT) W91-01633

**CITIZEN ENFORCEMENT OF CLEAN WATER ACT VIOLATIONS; THE SUPREME COURT STEERS A NEW COURSE OVER MUDDIED WATERS; GWALTNEY OF SMITHFIELD, LTD. V. CHESAPEAKE BAY FOUNDATION, INC.**  
S. J. Viscoli.  
Natural Resources Journal NRJOAB, Vol. 30, No. 2, p 459-469, 1990. 75 ref.

Descriptors: \*Clean Water Act, \*Judicial decisions, \*Public participation, \*Water law, \*Water pollution, Federal jurisdiction, Legal aspects, Legislation, Litigation, Water quality standards.

In *Gwaltney of Smithfield, Ltd. v. Chesapeake Bay Foundation, Inc.* the Supreme Court held that citizens may bring suit under the Federal Water Pollution Control Act (FWPCA) if they can make a good faith allegation of continuous or intermittent violations, but they may not bring suit for wholly past allegations. The Court's decision cleared up a three way conflict in the circuit courts' interpretation of the citizen suit provisions of the FWPCA. Between 1981 and 1984, the petitioner, Gwaltney of Smithfield, Ltd., discharged effluents in excess of its National Pollutant Discharge Elimination System (NPDES) permit. Respondents Chesapeake Bay Foundation and the National Resources Defense Council, both environmental groups, used FWPCA's citizen suit provision after first notifying the federal administrator and giving the state or federal authorities 60 days in which to enforce the NPDES violations. The Court's conclusion was based on an intricate explanation of the procedure Congress expected after the filing of the lawsuit and before the imposition of relief. In future, litigation is likely to focus on the gray area in between a past violation and a continuous violation. (MacKeen-PTT) W91-01634

**MAR DEL PLATA ACTION PLAN: REVIEW OF PROGRESS OF IMPLEMENTATION IN ASIA AND THE PACIFIC.**

For primary bibliographic entry see Field 6B. W91-01679

### REGIONAL OVERVIEW OF WATER QUALITY MONITORING.

For primary bibliographic entry see Field 6B. W91-01680

### 6F. Nonstructural Alternatives

**EYE TO EYE WITH HURRICANE GLORIA ON VIRGINIA'S TANGIER ISLAND.**  
Old Dominion Univ., Norfolk, VA.  
For primary bibliographic entry see Field 6B. W91-01620

### PERMIT REFORM THROUGH COASTAL CONSISTENCY PREVIEW: AN ANALYSIS OF ALASKA'S COORDINATED PROCESS.

Alaska Univ., Fairbanks.  
T. J. Gallagher.  
Coastal Management CZMJBF, Vol. 18, No. 2, p 179-193, 1990. 2 fig, 3 tab, 13 ref.

Descriptors: \*Administrative decisions, \*Alaska, \*Coastal zone management, \*Land development, \*Permits, Administration, Coasts, Federal jurisdiction, Legislation, Surveys.

In 1984 the state of Alaska created a process that combined permit review with coastal district review of proposed state and federal projects as provided by the Alaska Coastal Management Act. The process, managed by the Division of Governmental Coordination, incorporates permit reform strategies such as joint reviews, preapplication consultation, time-limiting techniques, and a rapid appeals process. This study examined the success of the process through a survey of 74 people, including permit applicants, both private and public, and representatives of coastal districts and state permitting agencies. Responses support the conclusion that the process achieves its primary goals of coordinating permits, increasing communication among participants, and increasing participation of local communities, as well as other benefits such as saving applicants and agencies time and money. Although all groups suggested changes to the process, all groups felt strongly that the process should be retained. (Author's abstract) W91-01621

### 6G. Ecologic Impact Of Water Development

**MODIFICATION OF COASTAL CURRENTS BY POWER PLANT INTAKE AND THERMAL DISCHARGE SYSTEMS.**  
Scripps Institution of Oceanography, La Jolla, CA.  
Center for Coastal Studies.  
For primary bibliographic entry see Field 8B. W91-01057

**UNEXPECTED HYDROLOGIC PERTURBATION IN AN ABANDONED UNDERGROUND COAL MINE: RESPONSE TO SURFACE RECLAMATION.**  
Indiana Geological Survey, Bloomington.  
For primary bibliographic entry see Field 4C. W91-01098

**FEDERAL-STATE TENSIONS IN AUSTRALIAN ENVIRONMENTAL MANAGEMENT: THE WORLD HERITAGE ISSUE.**  
Murdoch Univ. (Western Australia). Dept. of Political Science.  
B. Davis.  
Environmental and Planning Law Journal EPLJEX, Vol. 6, No. 2, p 66-78, June 1989. 24 ref.

Descriptors: \*Australia, \*Conservation, \*Environmental protection, \*Federal jurisdiction, \*Resource management, \*State jurisdiction, \*World Heritage sites, Legal aspects, Political aspects.

Nowhere is the conflict of values inherent in conservation and resource development more glaringly obvious than in the political and legal battles which have often accompanied proposed World Heritage Listing. From the wilderness of South West Tasmania through tropical rainforests of North Queensland to the open spaces of Kakadu, the struggle between competing interests has mirrored the shifting values of Australian society as a whole. Australia has met its internal obligations and appears willing to fund World Heritage sites and the States have received substantial financial compensation. The Commonwealth has only acted after repeated attempts at negotiation and in instances where mismanagement of resources is clearly evident at State levels. The extent to which State and Territorial decisions can be permitted to infringe upon foreign policy clearly has limits. Some of the unilateral actions taken by the Tasmanian, Queensland and Northern Territory Governments in directly confronting World Heritage Committee members can only be regarded as damaging to Australia's reputation, particularly as the aim is frequently political point-scoring, rather than any deep concern about environmental issues. (Brunone-PTT) W91-01102

**QUEENSLAND RAINFOREST AND WETLANDS CONFLICT: AUSTRALIA'S EXTERNAL AFFAIRS POWER-DOMESTIC CONTROL AND INTERNATIONAL CONSERVATION.**  
Lewis and Clark Coll., Portland, OR. Northwestern School of Law.  
For primary bibliographic entry see Field 6E. W91-01104

**ENVIRONMENTAL IMPACT ASSESSMENT: THE EXAMPLE OF MARINE BIOLOGY AND THE UK POWER INDUSTRY.**  
Central Electricity Generating Board, Fawley (England). Marine Biological Unit.  
For primary bibliographic entry see Field 6E. W91-01158

**DEEP-WELL IN THE NORTH-HOLLAND DUNE AREA.**  
Waterworks of North-Holland, Bloemendaal (Netherlands).  
For primary bibliographic entry see Field 4B. W91-01304

**GLOBAL CLIMATE CHANGE: IMPLICATIONS FOR AIR TEMPERATURE AND WATER SUPPLY IN CANADA.**  
Canadian Climate Centre, Downsview (Ontario).  
For primary bibliographic entry see Field 2B. W91-01388

**ENVIRONMENTAL IMPACTS OF DEVELOPMENT ON WETLANDS IN ARID AND SEMI-ARID LANDS.**  
University Coll., London (England). Dept. of Geography.  
G. E. Hollis.  
Hydrological Sciences Journal HSJODN, Vol. 35, No. 4, p 411-428, August 1990. 1 fig, 46 ref.

Descriptors: \*Ecological effects, \*Ecosystems, \*Environmental impact, \*Land development, \*Water resources development, \*Wetlands, Agriculture, Arid lands, Greece, New Zealand, Semi-arid lands, United States, Urbanization, Water resources management.

Wetlands, as defined by the Ramsar (Greece) Convention, are productive ecosystems providing goods and services for people. Negative effects from the 'development' of wetlands are exemplified through adverse climatic effects (Aral Sea, USSR), inadvertent environmental changes (Canadian Prairie Potholes), non-sustainable alternative uses (South Chad Irrigation Scheme, Nigeria), exacerbation of problems (Garaet El Haouaria, Tunisia), detrimental effects on rare species (Mikri Prespa, Greece), social disruption (Kissington Fadam, Nigeria), international obligations (Ich-

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keul, Tunisia), and sub-optimal management (Weija-Panbros, Ghana). The functions and values of wetlands are described in the 'Adams approach,' and are exemplified even for the 'dry' areas of the Hadejia-Nguru wetlands (Nigeria) and Lake Hula (Israel). Wetlands are threatened by agricultural intensification, pollution, engineering schemes, and urban development. Since the societies and institutions that degrade wetlands are themselves complex systems, an understanding of hydrology and ecology is insufficient for a wetland manager. Wetland destruction can be aided by misconceptions, public subsidy, international funds, local-scale planning, sectoral approaches, and narrow disciplinary thinking. National Wetland Strategies are needed, on the order of those presently developed in New Zealand and the United States. Hydrologists should be more involved in wetlands and their sustainable utilization. 'Political hydrology' must complement 'scientific hydrology.' (Author's abstract)  
W91-01462

#### DOWNSTREAM OF THE NOVOSIBIRSK HYDROELECTRIC STATION ON THE OB RIVER.

For primary bibliographic entry see Field 4A.  
W91-01544

#### CURRENT PROBLEMS AND PRACTICE OF ENGINEERING-GEOLOGICAL SURVEYS WHEN DESIGNING LARGE RESERVOIRS.

V. V. Kayaikin.

Hydrotechnical Construction HYCOAR, Vol. 23, No. 10, p 592-597, April 1990. 1 fig, 1 tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 10, p 28-32, October 1989.

Descriptors: \*Environmental engineering, \*Hydraulic design, \*Hydraulic engineering, \*Hydroelectric plants, \*Reservoir design, \*Soviet Union, Design criteria, Design standards, Ecological effects, Geological surveys, Hydraulic structures.

Current ecological problems include the negative consequences of cresting flatland reservoirs in the 1940-1950s, when protective measures were not specified, and at that time in the Soviet Union and abroad there was no experience in evaluating the interaction of large reservoirs with the environment. The reasons a negative attitude toward hydrotechnical construction in the past 20-30 years include underestimation of the significance of design and surveys of reservoirs in comparison with the main hydraulic structures, and shirking of design and surveying organizations from responsibility for errors. There recently occurred a noticeable decrease in the extent of engineering-geological surveys for large reservoirs. The technical scheme of these surveys should include the following elements: construction of engineering-geological models of the interaction of the reservoir with the geologic environment using analogs; organization of regime observations at the feasibility stage; limiting the possible effects of the reservoir on the geologic environment; recommendations on the structure technology and on engineering measures based on a combined model analysis of the interaction of the structures with the environment and limiting conditions of this interaction; inspection of the structures during construction and monitoring during their operation; and recommendations on reconstruction of the reservoir based on an analysis of the results of monitoring its interaction with the environment. A special agency should be created to develop the main directions for creating reservoirs, to coordinate observations and investigations, and to perform protective measures. (Fish-PTT)  
W91-01545

#### PRIORITIZING FLOW ALTERNATIVES FOR SOCIAL OBJECTIVES.

Colorado State Univ., Fort Collins. Water Resources Research Inst.  
M. Flug, and J. Ahmed.

Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 610-624, September/October 1990. 2 fig, 5 tab, 7 ref.

Descriptors: \*Environmental policy, \*Flow models, \*Multireservoir networks, \*Social aspects,

\*Water resources management, Canada, Environmental control, Flow equations, Mathematical models, Minnesota, Numerical analysis, Priorities, Reservoir operation, Simulation analysis, Urban planning.

Most mathematical modeling efforts in water resources fall far short of adequately including social and environmental objectives. Although many modelers have good intentions at the start of their analyses, the objective functions and constraint sets do not provide a good mechanism for addressing these resource issues. Results from a three-reservoir network simulation model were numerically rated for impact upon 22 natural resource attributes associated with seven resource objectives. Priority weighting of individual resource objectives was included, as well as the ranking of importance for each attribute to its respective resource objective. This technique provides a quantitative and objective approach to evaluate flow regulation alternatives. Input from special interest groups, the general public, and concerned individuals, as well as professionals in each resource area, are a part of the overall analysis. The simple technique provides a screening tool to identify good and bad flow alternatives. These methods were successfully applied to a three-reservoir system at Voyageurs National Park on the Minnesota and Canadian border. (Author's abstract)  
W91-01552

#### HYDROELECTRIC DAMS AND THE DECLINE OF CHINOOK SALMON IN THE COLUMBIA RIVER BASIN.

Marquette Univ., Milwaukee, WI. Dept. of Economics.  
D. E. Booth.  
Marine Resource Economics JMREDD, Vol. 6, No. 3, p 195-211, 1989. 8 tab, 29 ref.

Descriptors: \*Chinook, \*Columbia River, \*Dam effects, \*Ecological effects, \*Hydroelectric plants, \*Salmon, \*Water resources management, Environmental impact, Fish harvest, Fish migration, Fish populations, Oregon, Regression analysis, Spawning, Washington, Watershed management.

Chinook salmon runs into the mouth of the Columbia River (Oregon and Washington)—runs that historically were among the largest in the world—have declined significantly since the mid-1920s. The decline is thought to be partly attributable to the construction of hydroelectric dams. The magnitude of losses in chinook salmon runs caused by hydroelectric dams has been estimated using regression analysis. Such estimates are not only of historical interest but also can potentially affect the extent of efforts to mitigate salmon losses from hydropower operations. Congress has mandated that the magnitude of run losses caused by hydroelectric operations be considered in determining the extent of mitigation efforts. The total annual loss of chinook salmon resulting from both mainstem and tributary dams is estimated to be somewhere between 3,543,890 and 4,891,897 fish. In-river runs have recently been less than the weighted and lagged spawner escapement levels for both the spring and summer runs, suggesting that the continued existence of these runs is clearly threatened. The regression equations can be used to calculate the optimum level of spawner escapement and the maximum run level that results given the existence of dams. Unless the ocean harvesting of summer chinook is reduced or extensive mitigation efforts are undertaken, the summer run appears to be doomed. The question is as much ethical as it is economic, given that the destruction of the wild spring and summer runs would be essentially equivalent to the destruction of species. (Fish-PTT)  
W91-01560

#### HETEROTROPHIC MICROPLANKTON IN PLANKTON SUCCESSIONS AND SELF PURIFICATION PROCESSES ALONG THE YENISEI RIVER.

Oceanology Dept, Gelendzhik, Krasnodar, 353470 USSR.  
For primary bibliographic entry see Field 2H.  
W91-01616

#### COMPARATIVE ANALYSIS OF STATE ENVIRONMENTAL POLICY.

Colorado State Univ., Fort Collins. Dept. of Political Science.

J. P. Lester, and E. N. Lombard.  
Natural Resources Journal NRJAB, Vol. 30, No. 2, p 301-319, 1990. 1 fig, 4 tab, 39 ref.

Descriptors: \*Environmental policy, \*Environmental protection, \*Governmental interrelations, \*Policy making, \*State jurisdiction, Administrative agencies, Administrative decisions, Comparison studies, Data interpretation, Model studies, Political aspects.

Since the enactment of the National Environmental Policy Act (NEPA) of 1969, comparative state environmental policy studies have ranged from case studies to systematic input-output analyses. Conditions that promote or inhibit state environmental management have not been clearly identified due to research problems such as lack of theory, a reliance upon cross-sectional (versus longitudinal) analysis, limited measures of environmental effort, and inadequate analytical techniques. Sources of data on state commitment to environmental protection include Department of Commerce, The Council of State Governments, The Conservation Foundation, and the Fund for Renewable Energy and the Environment. Comparative state politics and policy research has been criticized as being atheoretical, endogenous, time-bound and methodologically unsound. An intergovernmental model is presented for future state environmental politics research which conceptualizes the implementation process at the state level. This model adopts a conceptual framework that represents the intergovernmental nature of policy implementation in the 1980s (and presumably in the 1990s). Such a framework would respond to the criticisms that previous research in this area has been too concerned with bivariate relationships (in the absence of a genuine theory) or has adopted a 'mainstream model,' which was endogenous (at best) or inaccurate (at worst) by assuming that only state-level variables influenced state policy outputs. Obstacles to the further theoretical advance of the state environmental politics and policy literature can be overcome by: (1) collecting data and analyzing relationships in a diachronic (longitudinal) fashion; (2) measuring state environmental policy with both expenditure and non-expenditure data and testing their relationships with predictor variables separately; (3) using path-analytic techniques whenever possible; and (4) combining quantitative (fifty-state) with qualitative (case studies of individual states) analyses. (MacKee-PTT)  
W91-01630

#### ABUNDANCE OF SPAWNING PACIFIC SALMON IN TWO LAKE SUPERIOR STREAMS, 1981-1987.

Department of Fisheries and Oceans, Sault Ste. Marie (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.  
For primary bibliographic entry see Field 8I.  
W91-01791

#### ESTIMATION OF RECRUITMENT FORGONE RESULTING FROM LARVAL FISH ENTRAINMENT.

Michigan Univ., Ann Arbor. School of Natural Resources.  
A. L. Jensen.  
Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 241-244, 1990. 1 tab, 1 fig, 12 ref.

Descriptors: \*Electric powerplants, \*Entrainment, \*Fish populations, \*Lake Erie, \*Model studies, \*Perch, Fish eggs, Larvae, Mathematical analysis.

A method for estimation of recruitment forgone, or lost, as a result of larvae and egg entrainment was developed; it requires parameter estimates only for recruited members of the population, which are more easily estimated than those for younger life stages. It requires no estimates for abundance. The method was applied to assess yellow perch larvae entrainment at the Monroe Power Plant, Monroe, Michigan, located on the

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### Group 6G—Ecologic Impact Of Water Development

western basin of Lake Erie. The number of yellow perch larvae entrained was 128 million, which is an enormous number, but larvae mortality is high and the recruitment forgone was 8933 fish. (Author's abstract)  
W91-01794

#### PERSPECTIVE ON AMERICA'S VANISHING STREAMS.

Alabama Univ., University. Dept. of Biology. A. C. Benke.  
Journal of the North American Benthological Society JNASEC, Vol. 9, No. 1, p 77-88, March 1990. 9 fig, 1 tab, 20 ref.

Descriptors: \*Dam effects, \*Data interpretation, \*Environmental impact, \*National Rivers Inventory, \*Resources management, \*Rivers, \*Stream classification, \*Stream conservation, \*Streams, \*Water resources management, Conservation, Dams, Stream exploitation, Stream improvement, United States, Water resources.

The free-flowing nature of streams in the U. S. has been dramatically altered over the past century, especially through construction of dams. The Nationwide Rivers Inventory (NRI) estimated a total of 5,200,000 km of streams in the contiguous 48 states, but only 2% (<100,000 km) have sufficient high quality features to be worthy of federal protection status. The future of this dwindling number of high-quality streams is in doubt as proponents if development compete with conservation interests. Hydropower projects are projected to be built well into the future with a large increase in small projects (55% more than in 1988) even though the total generating capacity of the U. S. would increase only 0.3%. On the other hand, conservation efforts have resulted in increasing levels of federal protection of streams since the 1960s. National River or Wild and Scenic River status now provides protection for almost 16,000 km of streams, but only about 10% are found east of the Mississippi River. Analysis of the NRI database showed that the greatest quantity and density of high-quality streams are found in the south-Atlantic states, where streams have the least protection. The greatest number of NRI streams are found in the Coastal Plain and Central Lowland physiographic provinces. The NRI analysis showed only 42 high-quality, free-flowing (no major dams) rivers > 200 km remaining in the 48 contiguous states. With continuing threats of exploitation, major conservation efforts are required to preserve these last free-flowing streams. (Author's abstract)  
W91-01812

## 7. RESOURCES DATA

### 7A. Network Design

#### EVALUATION OF DESIGNS OF PERIODIC COUNT SURVEYS FOR THE ESTIMATION OF ESCAPEMENT AT A FISHWAY.

Department of Fisheries and Oceans, Halifax (Nova Scotia). Biological Sciences Branch. B. M. Jessop, and C. J. Harvie.  
North American Journal of Fisheries Management NAJMDP, Vol. 10, No. 1, p 39-45, Winter 1990. 3 fig, 2 tab, 13 ref.

Descriptors: \*Fish migration, \*Nova Scotia, \*Sampling, Alewife, Fish passages, Fish populations, Quality control, Statistical analysis.

Counts of the number of alewives *Alosa pseudoharengus* migrating through the fishway on the Gaspareau River, Nova Scotia, were used to evaluate the accuracy and precision of various sampling schemes for estimating the population mean (true mean count/sample unit (15 min)). High variability in counts within day and season required more intensive sampling than suggested by previous studies to estimate the population mean to within a given percent relative error. Stratification in some cases doubled or trebled the precision of the estimated mean relative to the mean obtained from simple random sampling, whereas systematic sampling produced no gain in precision. Stratification to reduce the number of sample units required for a

given precision may reduce the power of a test to detect differences between annual estimates of population means, depending on their variances. The importance of these interrelated factors should be determined before a particular scheme and level of effort are chosen for sampling. (Author's abstract)  
W91-01384

#### VARIATIONAL SENSITIVITY ANALYSIS, DATA REQUIREMENTS, AND PARAMETER IDENTIFICATION IN A LEAKY AQUIFER SYSTEM.

California Univ., Los Angeles. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 2C.  
W91-01512

#### WATER-RESOURCES DATA-NETWORK EVALUATION FOR MONTEREY COUNTY, CALIFORNIA, PHASE 3: NORTHERN SALINAS RIVER DRAINAGE BASIN.

Geological Survey, Sacramento, CA. Water Resources Div.  
W. E. Templin, and R. C. Schluter.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4123, 1990. 104p, 9 fig, 12 tab, 76 ref.

Descriptors: \*California, \*Hydrologic data, \*Network design, \*Salinas River, \*Water resources data, Groundwater, Groundwater level, Groundwater management, Groundwater quality, Land use, Monterey County, Precipitation, Precipitation quality, Surface water, Surface water quality, Surface water records.

This report evaluates existing data collection networks and possible additional data collection to monitor quantity and quality of precipitation, surface water, and groundwater in the northern Salinas River drainage basin, California. Of the 34 precipitation stations identified, 20 were active and are concentrated in the northwestern part of the study area. No precipitation quality networks were identified, but possible data collection efforts include monitoring for acid rain and pesticides. Six of ten stream-gaging stations are active. Two surface water quality sites are sampled for suspended sediment, specific conductance, and chloride; one U.S. Geological Survey NASOAN site and one site operated by California Department of Water Resources make up the four active sampling locations; reactivation of 45 inactive surface water quality sites might help to achieve objectives described in the report. Three local networks measure water levels in 318 wells monthly, during peak irrigation, and at the end of the irrigation season. Water quality conditions are monitored in 379 wells; samples are collected in summer to monitor saltwater intrusion near Castroville and are also collected annually throughout the study area for analysis of chloride, specific conductance, and nitrate. An ideal baseline network would be an evenly spaced grid of index wells with a density of one per section. When baseline conditions are established, representative wells within the network could be monitored periodically according to specific data needs. (USGS)  
W91-01836

### 7B. Data Acquisition

#### APPLICATION OF A HOLLOW-FIBER, TANGENTIAL-FLOW DEVICE FOR SAMPLING SUSPENDED BACTERIA AND PARTICLES FROM NATURAL WATERS.

Geological Survey, Menlo Park, CA.  
For primary bibliographic entry see Field 5A.  
W91-01031

#### VARIATIONS IN SUSPENDED SEDIMENT AND ASSOCIATED TRACE ELEMENT CONCENTRATIONS IN SELECTED RIVERINE CROSS SECTIONS.

Geological Survey, Doraville, GA.  
For primary bibliographic entry see Field 2J.  
W91-01061

#### COMPUTED AND OBSERVED CURRENTS, ELEVATIONS, AND SALINITY IN A BRANCHING ESTUARY.

Plymouth Marine Lab. (England).  
For primary bibliographic entry see Field 2L.  
W91-01129

#### EVALUATION OF BIOLOGICALLY HARMFUL ULTRAVIOLET RADIATION IN ANTARCTICA WITH A BIOLOGICAL DOSIMETER DESIGNED FOR AQUATIC ENVIRONMENTS.

California Univ., San Francisco. Lab. of Radiobiology.  
D. Karentz, and L. H. Lutze.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 549-561, May 1990. 10 fig, 2 tab, 29 ref. NSF Grant No. DPP 87-12533 and DOE Contract No. DE-AC03-76-SF01012.

Descriptors: \*Dosimetry, \*Instrumentation, \*Measuring instruments, \*Radiometry, \*Ultraviolet radiation, Antarctica, Biological dosimeter, DNA.

A biological dosimeter has been developed for use in aquatic environments. This method is based on the sensitivity of a DNA repair-deficient strain of *Escherichia coli* (CSR06) to ultraviolet (UV) radiation. The dosimeter permits evaluation of the penetration of biologically active UV radiation within a water column, reflecting the potential effect of exposure over selected time intervals. With the use of various filters, the biological dosimeter can discriminate between the effects of UV-B (280-320 nm) and UV-A (320-400 nm) or other selected portions of the solar UV spectrum. During springtime ozone depletion over the Antarctic in 1988, a general relationship was observed between stratospheric ozone concentration and the contribution of incident solar UV-B radiation to lethality of dosimeter cells. The use of dosimeters within the water column indicated that significant amounts of UV-B can be transmitted to a depth of 10 m and biological effects of UV could be detected to 20 and 30 m. Biological dosimeters may provide a means of standardizing in-water UV measurements across all types of aquatic habitats and at any geographical location. (Author's abstract)  
W91-01138

#### SIMPLE PORE-WATER SAMPLER FOR COARSE, SANDY SEDIMENTS OF LOW POROSITY.

Nederlands Inst. voor Onderzoek der Zee, Texel. P. M. Saager, J. P. Smeets, and H. J. Ellermeijer.  
Limnology and Oceanography LIOCAH, Vol. 35, No. 3, p 747-751, May 1990. 3 fig, 2 tab, 9 ref.

Descriptors: \*Centrifugation, \*Interstitial water, \*Pore-water samplers, \*Samplers, \*Water sampling.

A simple, inexpensive, and highly efficient centrifuge tube allows nearly complete extraction of interstitial water from coarse, sandy sediments with porosities as low as 32%. The method is fast (5 min), efficient (55-92% of the available water is obtained), reliable, and can be performed on board ship at only 1,500 x g. The efficiency of the method permits a high sampling resolution (millimeter scale). The centrifuge tube is made of polyethylene and can be used for trace metal determinations after cleaning with acid. Due to a built-in filter, pore waters are clean and need not be filtered afterward, thus reducing the risk of contamination and possible oxidation artifacts. (Author's abstract)  
W91-01147

#### Q2X: AN (EXPERT) SYSTEMS APPROACH TO QUANTITY AND QUALITY MANAGEMENT OF STRATEGIC RESOURCES.

Surrey Univ., Guildford (England). Centre for Information Technology Research.  
For primary bibliographic entry see Field 5G.  
W91-01213

**MULTI-ELEMENT ANALYSIS OF NATURAL WATER USING INDUCTIVELY COUPLED PLASMA-SOURCE MASS SPECTROMETRY (ICP-MS).**  
Surrey Univ., Guildford (England). Dept. of Chemistry.  
For primary bibliographic entry see Field 5A.  
W91-01219

**BETA-GLUCURONIDASE AS A RAPID COLONY METRIC ASSAY FOR E. COLI IN WATER AND SEWAGE SAMPLES.**  
Surrey Univ., Guildford (England). Dept. of Microbiology.  
For primary bibliographic entry see Field 5A.  
W91-01242

**ROTAVIRUS AS A VIRAL INDICATOR IN SHELLFISH.**  
Surrey Univ., Guildford (England). Dept. of Microbiology.  
For primary bibliographic entry see Field 5A.  
W91-01243

**SIMULTANEOUS DUAL COLUMN, DUAL-DETECTOR GAS CHROMATOGRAPHIC DETERMINATION OF CHLORINATED PESTICIDES AND POLYCHLORINATED BIPHENYLS IN ENVIRONMENTAL SAMPLES.**  
Battelle Ocean Sciences, Duxbury, MA.  
For primary bibliographic entry see Field 5A.  
W91-01281

**DESIGN FOR AN OCCULT PRECIPITATION COLLECTOR.**  
Victoria Univ. of Manchester (England). Dept. of Environmental Biology.  
A. J. Spink, and A. N. Parsons.  
Atmospheric Environment ATENBP, Vol. 24A, No. 8, p 2263-2266, August 1990. 2 fig, 16 ref.

Descriptors: \*Acid rain, \*Cloud chemistry, \*Clouds, \*Measuring instruments, \*Mist, \*Precipitation gages, \*Rain gages, \*Sampling, Ammonium, Chemical analysis, Data acquisition, Hydrogen, Nitrates, Sulfates.

The prototype design for a cloud and mist collector is relatively simple and inexpensive design, excludes precipitation, making it suitable for long-term collection of chemical data related to occult deposition. Previous passive occult collector designs suffer from the drawback that the collectors collect rain and dry deposition as well as cloud and mist. The design presented here overcomes this problem to a large extent, although there is some contamination from dry deposition. In general, the occult samples collected had a considerably higher ionic concentration than the bulk samples. The average ratio of occult precipitation to bulk precipitation was as follows: nitrate, 5.09; sulfate, 3.94; ammonium, 6.08; and hydrogen, 2.38. (Lantz-PTT)  
W91-01291

**DEVICE FOR IN SITU DETERMINATION OF GEOCHEMICAL TRANSPORT PARAMETERS. I. RETARDATION.**  
Waterloo Univ. (Ontario). Dept. of Earth Sciences.  
For primary bibliographic entry see Field 5B.  
W91-01293

**EFFECT OF 3,4-DICHLOROANILINE AND METAVANADATE ON DAPHNIA POPULATIONS.**  
Centre for Technology and Policy Studies TNO, Apeldoorn (Netherlands). Dept. of Biology.  
For primary bibliographic entry see Field 5C.  
W91-01326

**LOGGING OF SPECIAL HYDROGEOLOGICAL WELLS.**  
Karlova Univ., Prague (Czechoslovakia). Faculty of Science.  
S. Mares, and A. el Dunia.  
Acta Universitatis Carolinae - Geologica AUCGAY, Vol. 1988, No. 1, p 131-142, 1988. 4

fig. 1 tab, 13 ref.

Descriptors: \*Borehole geophysics, \*Data acquisition, \*Geohydrology, \*Logging (Recording), \*Well logs, Aquifer characteristics, Aquifers, Boreholes, Geophysics, Groundwater data, Injection wells, Resistivity.

The task of groundwater resources protection represents one of the most difficult tasks of the hydrologist. Geophysical well logging has played an important role in completing geohydrological tasks particularly where boreholes are concerned. A new quantitative method for the evaluation of fluid resistivity logs has been developed which provides information on partial yields of individual inflows. In the wells which penetrate zones of high mineralized waters near their bottoms, it is possible to delineate individual inflows and to determine partial yields of each water producing horizon using only one fluid resistivity log recorded during or after the pumping test. Together with the formation resistivity log it is also possible to distinguish zones yielding fresh and mineral waters. Estimating the run-in characteristics of aquifers during a constant water injection into the well, it is possible to determine the thickness and the hydraulic conductivity of aquifers prepared for artificial recharge. (Lantz-PTT)  
W91-01360

**CORRESPONDENCE OF THE SCHEME AND METHOD OF CALCULATING THE STABILITY FACTOR.**  
For primary bibliographic entry see Field 8D.  
W91-01436

**DETERMINATION FROM SPACE OF ATMOSPHERIC TOTAL WATER VAPOR AMOUNTS BY DIFFERENTIAL ABSORPTION NEAR 940 NM: THEORY AND AIRBORNE VERIFICATION.**  
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. d'Optique Atmospherique.  
R. Frouin, P. Y. Deschamps, and P. Lecomte.  
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 6, p 448-460, 1990. 8 fig, 3 tab, 29 ref, append.

Descriptors: \*Aerosols, \*Atmospheric water, \*Data acquisition, \*Instrumentation, \*Measuring instruments, \*Meteorological data, \*Remote sensing, \*Satellite technology, \*Spectral analysis, \*Water vapor, Climatic data, Marine climates, Microwaves, Optical properties, Reflectance, Solar radiation.

A new technique is proposed to estimate atmospheric total water vapor amounts from space. The technique consists of viewing the Earth's surface in two spectral channels, one narrow, the other wide, centered on the same wavelength at the water vapor absorption maximum near 940 nm. With these characteristics, the ratio of the solar radiance measured in the two channels is independent of the surface reflectance, and yields a direct estimate of the water vapor amount integrated along the optical path. To test the technique, a two-channel radiometer was designed and built based on the above concept. Airborne experiments carried out with the new device demonstrate the technique's feasibility under clear sky conditions over both sea and land. Over the ocean and in the presence of thick aerosol layers, however, total water vapor amounts may be underestimated by as much as 20%. Compared to satellite microwave techniques, which are applicable under most weather conditions, the proposed technique has the advantage of simplicity and constitutes a promising alternative over land, where microwave radiometry is inappropriate. (Author's abstract)  
W91-01472

**AIRCRAFT-BASED RADIOMETRIC IMAGING OF TROPOSPHERIC TEMPERATURE AND PRECIPITATION USING THE 118.75-GHZ OXYGEN RESONANCE.**  
Georgia Inst. of Tech., Atlanta. School of Electrical Engineering.  
A. J. Gasiewski, J. W. Barrett, P. G. Bonanni, and

D. H. Staelin.  
Journal of Applied Meteorology JAMOAX, Vol. 29, No. 7, p 620-632, July 1990. 9 fig, 2 tab, 19 ref.  
NASA Grant NAG 5-10.

Descriptors: \*Air temperature, \*Emission spectrometry, \*Meteorology, \*Precipitation, \*Radiometry, \*Remote sensing, \*Resonance, Aircraft, Cloud cover, Convective precipitation, Infrared imagery, Oxygen, Spectrometers, Water vapor.

Passive microwave sounding of terrestrial atmospheric temperature profiles was first suggested in 1963. Imaging of O<sub>2</sub> emissions using the 118.75-GHz (1-) resonance has been investigated for tropospheric and stratospheric remote sensing of atmospheric temperature and precipitation. An imaging millimeter-wave spectrometer (MTS) was constructed. The MTS collected data during 33 flights of a high-altitude aircraft in 1986, yielding the first high spatial resolution microwave images of atmospheric O<sub>2</sub> brightness. The isolated 118-GHz line offers higher spatial resolution and precipitation sensitivity than O<sub>2</sub> lines in the 5-mm band near 60 GHz. The brightness temperature perturbations of clouds in nonprecipitating regions are typically twice as large in the 118-GHz channels relative to comparable 60-GHz channels. However, observations over cirrus anvils show that the 118-GHz brightnesses are not adversely sensitive to some optically opaque cloud cover. Thus, these channels are expected to be useful for temperature sounding in the presence of clouds, although retrieval ambiguities can result from variations in the water vapor profile and surface emissivity. Over deep convective precipitation, 118-GHz brightness temperature images are characterized by decreases of up to 200 K due to strong scattering in the storm core. The amplitudes and shape of the 118-GHz spectrum contain information on the cell top by virtue of the various peaking altitudes of the 118-GHz weighting functions. Precipitation cells observed by the MTS sometimes appear in bands or rows, and have been accompanied by periodic radiance structures. (Author's abstract)  
W91-01488

**EXPERIMENTAL TESTING OF TRANSIENT UNSATURATED FLOW THEORY AT LOW WATER CONTENT IN A CENTRIFUGAL FIELD.**  
Geological Survey, Menlo Park, CA. Water Resources Div.  
For primary bibliographic entry see Field 2G.  
W91-01514

**SOLUTE TRANSPORT WITH MULTISEGMENT, EQUILIBRIUM-CONTROLLED REACTIONS: A FEED FORWARD SIMULATION METHOD.**  
Geological Survey, Menlo Park, CA. Water Resources Div.  
For primary bibliographic entry see Field 5B.  
W91-01520

**MASS ARRIVAL OF SORPTIVE SOLUTE IN HETEROGENEOUS POROUS MEDIA.**  
Royal Inst. of Tech., Stockholm (Sweden).  
For primary bibliographic entry see Field 5B.  
W91-01521

**AUTOMATING WATER RESOURCE MANAGEMENT.**  
V. Speed.  
Water Engineering and Management WENMD2, Vol. 137, No. 8, p 28-30, August 1990. 4 fig.

Descriptors: \*Databases, \*Geographic information systems, \*Mapping, \*Water resource management, \*Water resources data, Arid lands, Automation, Benefits, Data interpretation, Government supports, Semiarid lands.

In order to track water resource information and how it relates to independent consumer interests in the irrigable land in the Mid-Pacific Region of the US, the Bureau of Reclamation (Department of the Interior) uses geographic information system (GIS)

## Field 7—RESOURCES DATA

### Group 7B—Data Acquisition

technology—a computerized mapping/database management system that allows users to capture, edit, display, and analyze geographic data. The database allows them to combine information from various sources into a single map displaying areas of concern. The Computer Assisted Cartographic (CAC) document was created to outline functional requirements and allow a more appropriate automation tool. A system was needed that could take data from a variety of different sources, analyze it, and store it in individual layers. When the system requirements were completed, the CAC included such particulars as scale and projection transformations, topological overlays, addition of new layers to existing drawings and the ability to create new layers from existing layers. The Bureau purchased a general-purpose data management package that allows users to bring survey information into the database from many sources. It consists of the ARC system, which stores cartographic data, and the INFO relational database, which stores attribute data. In its efforts to automate the everyday analysis and mapping tasks, the Bureau has expanded its role in water resource management to better provide the districts it serves with accurate and fair water contracts. Their efforts are contributing to the resolution of litigation and water disputes in the arid and semiarid western land. (Fish-PTT) W91-01563

#### BALANCING THE SCADA EQUATION FOR THE FIRST-TIME USER.

Control Mfg. Co., Belmont, CA.

T. Meyer.

Water Engineering and Management WENMD2, Vol. 137, No. 8, p 32-33, August 1990. 1 fig.

Descriptors: \*Computer models, \*Computer programs, \*Data acquisition, \*Supervisory control, \*Wastewater management, \*Water management, Cost-benefit analysis, Monitoring, SCADA system, Wastewater facilities.

Over the past five years, supervisory control and data acquisition (SCADA) has evolved from a fledgling tool for the water industry to a reliable, sophisticated means of monitoring, reporting, and controlling the operation of modern water/wastewater plants. A successful installation will reduce manpower requirements by 50% or more, ease future expansion and effortlessly keep pace with the ever-increasing paperwork requirements of regulatory agencies. The benefits of SCADA are not restricted to large plants. SCADA becomes an asset when the costs of installing the system are surpassed by the benefits achieved from the system. System architecture is critical to a successful SCADA system. Over-design and under-design are dangers paid for by high cost, complex maintenance, increased variables, and undertrained operators. Personal computer-platform SCADA systems perform best (most quickly and dependably) when user programs are solved outside of the personal computer. If the system requires only monitoring and direct output of operator commands to the field, remote terminal units can be used. Manual and semi-automatic backups must be designed into the system to maintain all critical processes in the event of malfunction. Today's technology has brought simple SCADA control, financially, within the reach of almost every district. A basic SCADA system can be purchased for less than \$30,000. (Fish-PTT) W91-01564

#### MEASUREMENT OF EXOENZYMATIC ACTIVITY IN STREAMBED SEDIMENTS USING METHYLLUMBELLIFERYL-SUBSTRATES.

Max-Planck-Inst. fuer Limnologie, Schilf (Germany, F.R.). Limnologische Flussstation.

For primary bibliographic entry see Field 2J.

W91-01587

#### METHOD OF MEASURING THE DEHYDROGENASE ACTIVITY OF SEDIMENTS.

Sofia Univ. (Bulgaria). Dept. of Ecology.

For primary bibliographic entry see Field 2J.

W91-01588

#### APPLICATION OF THE ISOTOPE DILUTION PRINCIPLE TO THE DETERMINATION OF SUBSTRATE INCORPORATION BY AQUATIC BACTERIA.

Warsaw Univ. (Poland). Dept. of Environmental Microbiology.

For primary bibliographic entry see Field 2H.

W91-01599

#### IMPROVED ASSESSMENT OF BACTERIAL PRODUCTION: COMBINED MEASUREMENTS OF PROTEIN SYNTHESIS VIA LEUCINE AND CELL MULTIPLICATION VIA THYMIDINE INCORPORATION.

Konstanz Univ. (Germany, F.R.). Limnological Inst.

For primary bibliographic entry see Field 2H.

W91-01605

#### NOTE ON THE MEASUREMENT OF PRODUCTION OF PHOTOTROPHIC BACTERIA IN DEEP LAYERS.

Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.

For primary bibliographic entry see Field 2H.

W91-01614

#### USE OF POLARIZATION TO CHARACTERIZE PRECIPITATION AND DISCRIMINATE LARGE HAIL.

National Severe Storms Lab., Norman, OK.

For primary bibliographic entry see Field 2B.

W91-01656

#### COMPARISON OF A GENE PROBE WITH CLASSICAL METHODS FOR DETECTING 2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) BIODEGRADING BACTERIA IN NATURAL WATERS.

Oregon State Univ., Corvallis. Dept. of Microbiology.

For primary bibliographic entry see Field 5B.

W91-01664

#### MEASUREMENT OF SURFACE TENSION IN AGRICULTURAL WASTE SLURRIES.

Cambridge Univ. (England). Dept. of Chemical Engineering.

For primary bibliographic entry see Field 5D.

W91-01702

#### SPECIATION OF MERCURY COMPOUNDS IN WASTE WATER BY MICROCOLUMN LIQUID CHROMATOGRAPHY USING A PRECONCENTRATION COLUMN WITH COLD-VAPOR ATOMIC ABSORPTION SPECTROMETRIC DETECTION.

Nagoya Univ. (Japan). Dept. of Applied Chemistry.

For primary bibliographic entry see Field 5A.

W91-01716

#### SIMPLE METHOD FOR ESTIMATING DERMAL ABSORPTION OF CHEMICALS IN WATER.

ENVIRON Corp., Washington, DC.

For primary bibliographic entry see Field 5B.

W91-01731

#### BENTHIC MACROPHYTE COMMUNITY CORE SAMPLER.

Wayne State Univ., Detroit, MI. Dept. of Biological Sciences.

M. D. Fornwall, and A. Hough.

Journal of Freshwater Ecology JFREDW, Vol. 5, No. 3, p 379-382, June 1990. 1 fig, 10 ref. NSF Grant DEB81-D3528.

Descriptors: \*Benthic flora, \*Biological samples, \*Bottom sampling, \*Samplers, \*Submerged aquatic plants, Aquatic soils, Cores, Ecosystems, Macrophytes, Sediments.

A coring device for quantitative sampling of benthic submerged macrophyte beds was constructed.

The device has a relatively large-diameter barrel to include both above and below ground biomass, a long (variable length) handle for direct control, and a simple sample retaining mechanism to maximize ease of operation and to minimize cost. The sampler is effective in sediments ranging from organic muds to sandy clays, and in water depths of up to four meters. The 30-cm barrel consistently reaches below the maximum depth of plant roots in the sediment. This sampler cuts and retains dense macrophyte growth quite well. Tall shoots are difficult to sample however, requiring careful, vertical lowering of the sampler, and thus the sampler is not well suited for beds of tall plants. The large root systems of the Nymphaeaceae challenge the sampler also, but at their relatively shallow depths it is possible to achieve the cutting necessary to produce acceptable samples. These types of problems require the direct control provided by the pole-type handle. A short-handled version of this sampler could be adapted for diver use. (Agostine-PTT) W91-01747

#### USE OF RESISTIVITY SOUNDINGS TO DETERMINE LANDFILL STRUCTURE.

Northern Illinois Univ., De Kalb. Dept. of Geology.

For primary bibliographic entry see Field 5B.

W91-01786

#### MEASUREMENT AND INTERPRETATION OF LOW LEVELS OF DISSOLVED OXYGEN IN GROUND WATER.

Geological Survey, Menlo Park, CA.

A. F. White, M. L. Peterson, and R. D. Solbau. Ground Water GRWAAP, Vol. 28, No. 4, p 584-590, July/August 1990. 6 fig, 1 tab, 22 ref.

Descriptors: \*Analytical methods, \*Dissolved oxygen, \*Groundwater pollution, \*Metals, \*Path of pollutants, \*Radionuclides, \*Selenium, Agricultural runoff, Analytical techniques, Aquifers, California, Kesterson Reservoir, Monitoring.

A Rhodazine-D colorimetric technique was adapted to measure low-level dissolved oxygen concentrations in groundwater. Prepared samples containing between 0 and 8.0 micromoles/l dissolved oxygen in equilibrium with known gas mixtures produced linear spectrophotometric absorbance with a lower detection limit of 0.2 micromoles/l. Excellent reproducibility was found for solutions ranging in composition from deionized water to sea water with chemical interferences detected only for easily reduced metal species such as ferric ion, cupric ion and hexavalent chromium. Such effects were correctable based on parallel reaction stoichiometries relative to oxygen. The technique, coupled with a downhole wire line tool, permitted low-level monitoring of dissolved oxygen in wells at the selenium-contaminated Kesterson Reservoir in California. Results indicated a close association between low but measurable dissolved oxygen concentrations and mobility of oxidized forms of selenium in the shallow aquifer which were in general electrochemical disequilibrium. (Author's abstract) W91-01788

#### PRIMER ON CLOTHING SYSTEMS FOR COLD-WEATHER FIELD WORK.

Geological Survey, Bow, NH. Water Resources Div.

J. C. Denner.

Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-415, April 1990. 14p, 2 fig, 4 tab, 9 ref.

Descriptors: \*Acclimatization, \*Clothing, \*Cold regions, \*Data acquisition, \*Hydrologic data, \*Hypothermia, \*Thermal stress, High-loft insulators, Layering system, Moisture absorption, Thermal conductance, Thin insulators.

Hypothermia in cold environments can be prevented by physiological adaptation and by the proper use of cold weather clothing. The human body adjusts to cold temperature by increasing the rates

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of basal metabolism, specific dynamic action, and physical exercise. Heat loss is reduced by vasoconstriction. Clothing systems for cold weather reduce loss by providing insulation and protection from the elements. Satisfactory cold-weather clothing is constructed of wool fabrics or the synthetic fibers polypropylene and polyester. Outerwear suitable for cold climates is insulated with down, high-loft polyester fiberfills, or the new synthetic thin insulators. (USGS)  
W91-01846

**MEASURING TECHNIQUES FOR GAS/SOLID FLUIDIZED BED REACTORS (MEBTECHNIKEN FÜR GAS/FESTSTOFF-WIRBELSCHICHTREAKToren).**  
Hamburg Univ. (Germany, F.R.).  
For primary bibliographic entry see Field 5D.  
W91-01896

**SHOT-SENSOR METHOD OF MEASURING CURRENTS IN SHALLOW ESTUARINE WATERS.**  
New Hampshire Univ., Durham. Jackson Estuarine Lab.  
F. E. Anderson.  
Estuaries ESTUDO, Vol. 13, No. 3, p 250-257, September 1990. 11 fig, 1 tab, 14 ref. Sea Grant No. NA86AA-D-SG-047.

Descriptors: \*Current meters, \*Estuaries, \*Measuring instruments, \*Shallow water, \*Shot-sensor device, Currents, Data acquisition, Flow velocity, Performance evaluation, Tides.

A current measuring device, the Shot-Sensor, was developed as a low cost alternative to measuring water flow speeds and directions using conventional, more expensive instrumentation. The device releases stainless steel shot, of known size and settling speed, into a flowing water mass. As the shot settles, it is dispersed by currents and ends up in settling traps. Mean current speed and direction can be calculated from the patterns of dispersal and the percentages of shot of various sizes in the traps. Mean current speed and direction can be calculated from the patterns of dispersal and the percentages of shot of various sizes in the traps. Determination of precision and accuracy indicate that the Shot-Sensor can measure within a few cm/sec of more expensive meters and may be suitable for some shallow-water applications. Speed range of the Shot-Sensor is presently limited to between 3 and 40 cm/sec, but further development could allow this range to be extended. (Author's abstract)  
W91-01900

**ENVIRONMENTAL TESTING-ISSUES AND DIRECTIONS.**  
For primary bibliographic entry see Field 5G.  
W91-01913

**CHARACTERIZATION OF COMPOST WITH RESPECT TO ITS CONTENT OF HEAVY METALS, PART I: SAMPLE DIGESTION AND ICP-AES ANALYSIS.**  
Amsterdam Univ. (Netherlands). Vakgroep Milieu-kunde.  
For primary bibliographic entry see Field 5E.  
W91-01986

**MULTIRESIDUE METHOD BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY-BASED FRACTIONATION AND GAS CHROMATOGRAPHIC DETERMINATION OF TRACE LEVELS OF PESTICIDES IN AIR AND WATER.**  
California Univ., Davis. Dept. of Environmental Toxicology.  
For primary bibliographic entry see Field 5A.  
W91-02038

## 7C. Evaluation, Processing and Publication

**IDENTIFYING FLOW PATHS IN MODELS OF SURFACE WATER ACIDIFICATION.**

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5B.  
W91-01033

**HYDRODYNAMIC MODEL FOR WIND-DRIVEN AND TIDAL CIRCULATION IN THE ARABIAN GULF.**  
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Water Resources and Environment Div.  
For primary bibliographic entry see Field 2L.  
W91-01077

**TEMPORAL VARIABILITY OF SOIL WETNESS AND ITS IMPACT ON CLIMATE.**  
Princeton Univ., NJ. Geophysical Fluid Dynamics Program.  
For primary bibliographic entry see Field 2G.  
W91-01090

**SALINITY STRATIFICATION IN A RIVER-DOMINATED ESTUARY.**  
Alabama Marine Resources Lab., Dauphin Island.  
For primary bibliographic entry see Field 2L.  
W91-01130

**TEST OF THE ASSUMPTIONS AND PREDICTIONS OF RECENT MICROALGAL GROWTH MODELS WITH THE MARINE PHYTOPLANKTON PAVLOVA LUTHERI.**  
Hawaii Univ., Honolulu. Dept. of Oceanography.  
For primary bibliographic entry see Field 2L.  
W91-01139

**PROCEEDINGS OF STORMWATER AND WATER QUALITY MODEL USERS GROUP MEETING.**  
For primary bibliographic entry see Field 5G.  
W91-01188

**USER DEFINED CONDUITS IN THE EXTRAN BLOCK OF SWMM.**  
Tulane Univ., New Orleans, LA.  
For primary bibliographic entry see Field 4C.  
W91-01189

**IMPROVEMENTS TO SURCHARGE CALCULATIONS IN EXTRAN.**  
Brown and Caldwell, Seattle, WA.  
L. K. Belvin.  
IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 33-42, 6 fig, 4 ref.

Descriptors: \*Flow profiles, \*Storm Water Management Model, \*Storm water management, \*Unsteady flow, \*Urban hydrology, \*Urban runoff, Data interpretation, Flood peak, Fluid dynamics, Mathematical studies, Pipe flow, Storm runoff.

Unsteady non-uniform surcharged flow is a condition frequently found in combined sewer systems. Yet, to date there is no well documented, publicly available sewer model which can accurately simulate such flows. The Extended Transport (EXTRAN) block of the EPA's Stormwater Management Model (SWMM) was designed to model such flows, but it has deficiencies. Continuity is not necessarily preserved in the model, especially under surcharge conditions, which causes errors in flow balance, peak flow time and peak heads. In this paper, modifications have been made to the model to improve the non-uniform surcharge flow calculations. By accounting for fluid volumes in the pipes, the calculations of continuity are improved, especially under surcharge. These modifications were incorporated into the existing model without changing the input or output parameters. The improved model does not require additional user training to operate the model. The result is a publicly available, well-documented hydraulic sewer model that more accurately models unsteady, non-uniform surcharge flows. As demonstrated in a sample application, the modified

EXTRAN code preserves continuity and matches computed head values better than the original EXTRAN code. Because the improvements were made without changing the user parameters of the model, this new version of EXTRAN, in conjunction with the available EXTRAN documentation, is the only publicly available, well-documented program that accurately models surcharge flow under non-uniform, unsteady conditions. (See also W91-01188) (Lantz-PTT)  
W91-01192

**URBAN RUNOFF MODELING FOR ADMINISTRATIVE PURPOSES.**  
Wright Water Engineers, Inc., Denver, CO.  
For primary bibliographic entry see Field 4C.  
W91-01193

**MODELING STUDIES FOR THE CITY OF AUSTIN STORMWATER MONITORING PROGRAMS.**  
Austin Environmental Protection Dept., TX.  
For primary bibliographic entry see Field 4C.  
W91-01194

**HYDROLOGIC DATA AUTOMATION USING AUTOCAD.**  
Kiowa Engineering Corp., Denver, CO.  
J. Y. Chang, and J. C. Y. Guo.  
IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 142-148, 1 fig, 3 tab, 3 ref.

Descriptors: \*Automation, \*Computer programs, \*Data storage and retrieval, \*Urban hydrology, \*Urban runoff, \*Water resources management, Case studies, Colorado, Computer-aided design, Computers, Denver, Management planning.

CUHPCAD is a computer program developed for the promotion of hydrological data automation, which serves as a control program to link between AutoCAD and the CUHP program. The program was developed for the purpose of hydrologic data automation, and consists of two parts: (1) the CUHP.LSP program which analyzes and stores the data generated by using AutoCAD; and (2) the CUHPCAD.BAS program which can abstract the data from CUHP.LSP and perform data calculation and preparation of CUHP data input files. The CUHPCAD program has been tested and applied to a major drainage basin planning project for the study of Second, Third, and Box Elder Creeks in Adams County, CO. The study area is approximately 70 sq mi. Total sub-basin number is 390. Soil types include A, B, and C groups based on Soil Conservation Service's soil survey report. Land use for existing conditions are mostly agricultural. Three baseline hydrological conditions for the frequencies of 20, 5-, 10-, and 100-year need to be modeled by using CUHP which includes existing basin conditions, and future basin conditions with or without the proposed New Denver Airport. With the use of CUHPCAD, The hydrology portion of this project was completed within the allowable schedule and budget. After the manual preparation of the basin map, soil map, and the land use map, the input of all maps to the computer was completed. (Lantz-PTT)  
W91-01202

**DISTRIBUTED RAINFALL-RUNOFF MODELING BASED ON DIGITAL MAP DATABASE.**  
Colorado Univ. at Denver. Dept. of Civil Engineering.  
L. E. Johnson.  
IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 149-160, 10 fig, 7 ref. National Science Foundation Grant No. ECE-8513122.

Descriptors: \*Computer models, \*Data interpretation, \*Maps, \*Rainfall-runoff relationships, \*Urban hydrology, \*Urban runoff, Computer programs, Computers, Databases, Digital analysis, Graphical analysis, Runoff, Simulation analysis, Slopes.

## Field 7—RESOURCES DATA

### Group 7C—Evaluation, Processing and Publication

A cascade-of-reservoirs rainfall-runoff model, called MAPHYD, has been developed which incorporates automatic generation of model input data using geographical information system functions integrated into a user friendly workstation. Digital terrain modeling is conducted to obtain slope and the direction of slope for a user-selectable grid cell resolution. Associated data on soils and infiltration characteristics, land use and percent impervious, antecedent moisture conditions, and rainfall distribution are simulation routines. Output result of the spatial distribution of runoff at each time step are displayed using an interval color scale. Input, retrieval, and editing of the digital database is accomplished by interactive computer graphics techniques. (See also W91-01188) (Author's abstract) W91-01203

**PC-SYNOP, A RAINFALL ANALYSIS TOOL.** Woodward-Clyde Consultants, Oakland, CA. E. W. Strecker, E. D. Driscoll, and G. E. Palhegyi.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 161-172, 3 fig, 7 tab, 9 ref.

Descriptors: \*Computer programs, \*Data processing, \*Microcomputers, \*Rainfall-runoff relationships, \*Storm runoff, \*Synoptic Rainfall Analysis Program, \*Urban hydrology, \*Urban runoff, Computers, Runoff, Statistical analysis.

EPA's Synoptic Rainfall Analysis Program (SYNOPSIS) for the personal computer analyzes an hourly rainfall record, that can be obtained on floppy disk from the National Climatic Data Center, for rain gauges located throughout the country. It generates a variety of storm event based summary statistics. By specifying a minimum dry period that separates successive storms, SYNOPSIS groups the hourly rainfall record into storm events and analyzes the resulting record. A user friendly interface has been provided for the selection of computational and printout options. Some of the added features include the ability to: (1) select either a water year or calendar year organization, (2) to conduct an analysis on a seasonal basis (useful for dealing with the pronounced wet and dry seasons in some areas of the country), (3) to exclude from the statistical analyses all storm event volumes that are less than some user specified minimum (used to determine the characteristics of only those storm events that will produce runoff), and (4) the ability to write out a separate file containing storm event information on all storm events in the record for downloading to a spreadsheet or statistical analysis program. A cooperative analysis is presented in tabular form that examines the effects and some of the implications of a minimum storm event that generates runoff. (See also W91-01188) (Lantz-PTT) W91-01204

**COMPUTER AIDED PLANNING OF DRAINAGEWAY IMPROVEMENTS MADE EASY WITH LOTUS 1-2-3.**

Greenhorne and O'Mara, Inc., Aurora, CO. M. B. Cooke, and R. P. Gildersleeve.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 173-182, 3 ref.

Descriptors: \*Computer programs, \*Computer-aided design, \*Drainage systems, \*Storm water management, \*Urban hydrology, \*Urban runoff, Channels, Culverts, Data processing, Hydraulic properties, Pipes, Storm runoff, Stormwater Master Plan Model.

A computer program was developed which combines an hydraulics package with a cost-estimating program to allow quick planning level comparisons of alternative planning scenarios. The Stormwater Master Plan Model (SMPM) is a menu-driven program for those involved in the master planning of drainageways. The program computes hydraulic characteristics of existing and planned drainageway improvements and estimates their

cost. SMPM models four types of drainageway elements: channels, culverts bridges and detention ponds. Channels can be grasslined, riprap or concrete and can include concrete or riprap drop structures. The program accommodates four types of culverts: corrugated metal pipe, corrugated metal arch, concrete pipe and reinforced concrete box culverts. One of the most powerful features of SMPM is its cost routine. The program computes a planning level cost estimate for each drainageway element included in the model. The cost is based on user defined unit costs for excavation, riprap, pipe right of way and other common capital cost items. Modifications to design flows and any drainageway element can be made quickly and easily via the menu. SMPM is designed for those that are familiar with running LOTUS 1,2,3 Release 2. Each model can contain up to 35 channel, culvert or bridge elements. (See also W91-01188) (Lantz-PTT) W91-01205

**HYETOGRAPH COMPOSITING EFFECTS ON URBAN RUNOFF MODELLING.**

Kiowa Engineering Corp., Denver, CO. M. P. Jansek, and B. R. Urban.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 183-195, 15 fig, 1 tab, 1 ref.

Descriptors: \*Data processing, \*Hyetographs, \*Model studies, \*Rainfall-runoff relationships, \*Urban hydrology, \*Urban runoff, Case studies, Colorado, Computer models, Denver, Flood peak, Runoff, Storm runoff.

Rainfall and runoff data from a 3.08 sq mi urban watershed in Denver, Colorado was used to investigate the effects of compositing several recorded rainstorm hyetographs on urban stormwater runoff modelling results. The watershed in this semi-arid region had data at five rain gauges and two flow gages, which provided the basis for calibrating an Urban Drainage and Flood Control District version of the Storm Water Management Model (SWMM). The calibrated model was then used to examine the effects of runoff calculations using a single composite hyetograph for each storm. Compositing of hyetographs was performed using two types of area weighted techniques. The five hyetographs were then composited directly using the recorded rainfall depth at each clock time interval. In addition, the hyetographs were composited using a technique that first shifted the five gage records so the peak rainfall time increments of each hyetograph were aligned. In this study very little difference was found in peak flow and runoff volume simulations between the two types of hyetographs compositing techniques, namely compositing straight across or compositing using peak preservation. However, the author's believe that it is premature to accept this finding as a general finding applicable under all conditions. Both methods tended to underestimate peak flows and volumes when compared against the calibrated multi-rain gage hyetograph runs using a calibrated SWMM model. (See also W91-01188) (Lantz-PTT) W91-01206

**FLOOD HYDROGRAPH FOR UNGAGED WATERSHED.**

Stewart Environmental Consultants, Inc., Fort Collins, CO. W. C. Cunha.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 196-207, 3 fig, 1 tab, 8 ref.

Descriptors: \*Data interpretation, \*Flood hydrographs, \*Model studies, \*Rainfall-runoff relationships, \*Storm runoff, \*Urban hydrology, \*Urban runoff, Computer models, Flood routing, Hydrographs, Infiltration.

The flood hydrograph for ungaged watershed can be calculated utilizing the Soil Conservation Service (SCS) data and physically-based soil infiltration equations, and the XSRAIN model. This software utilizes physically-based infiltration equations to

calculate the abstraction of rainfall in basins for which there is a minimum of available hydrologic information. The hydraulic soil parameters can be easily calculated from a relationship between the SCS's curve number (CN) and the mentioned parameters. Large heterogeneous watersheds can be partitioned into several smaller homogeneous sub-basins. Routing of excess rainfall is performed with the SCS dimensionless unit hydrograph to produce a runoff hydrograph for each individual sub-basin. The final flood hydrograph is obtained by routing and summing the runoff hydrographs of sub-basins according to the travel time associated with them. Rain data can be supplied by simply providing a depth and duration of rain or the user may input variable rain depths. (See also W91-01188) (Lantz-PTT) W91-01207

**UNIT-HYDROGRAPH PROCEDURES FOR ARID LANDS.**

G. V. Sabol, J. M. Rumann, D. Khalili, and T. A. Dominguez.

IN: Proceedings of Stormwater and Water Quality Model Users Group Meeting, October 3-4, 1988, Denver, CO. EPA Report No. EPA/600/9-89/001, January 1989. p 208-216, 2 tab, 6 ref.

Descriptors: \*Arid lands, \*Arizona, \*Data interpretation, \*Flood control, \*Rainfall-runoff relationships, \*Unit hydrographs, Graphical analysis, Hydrographs, Mathematical studies, Storm runoff.

Unit hydrographs are used in most hydrometeorological flood analyses in the arid west and throughout the U.S. Recently, two studies were conducted for the Flood Control District of Maricopa County, Arizona, for the purpose of selecting or developing synthetic unit hydrograph procedures for use in the County. A study was conducted to compile S-graphs from the southwest, and to select S-graphs for use in the various physiographic land forms within Maricopa County. A second study was conducted to collect rainfall-runoff data from the southwest and to analyze this data to develop a synthetic hydrograph procedure for Maricopa County. Rainfall-runoff data was compiled from the Walnut Gulch Experimental Watershed in Tombstone, Arizona, Tucson Experimental Watersheds, urban hydrology programs of the USGS in Denver and Albuquerque, and a USGS data collection program in Wyoming. The procedure to synthesize the Clark unit hydrograph was: (1) Estimate the time of concentration (TC); (2) estimate the storage coefficient (R); and (3) develop the appropriate time-area relation which would be expected to fall within appropriate envelopes or select the default time-area relations. (See also W91-01188) (Lantz-PTT) W91-01208

**DETERMINATION OF DESIGNATED FLOOD-WAY BOUNDARIES AROUND LONG ISLANDS IN STREAM CHANNELS.**

Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.

For primary bibliographic entry see Field 2E. W91-01209

**Q2X: AN (EXPERT) SYSTEMS APPROACH TO QUANTITY AND QUALITY MANAGEMENT OF STRATEGIC RESOURCES.**

Surrey Univ., Guildford (England). Centre for Information Technology Research. For primary bibliographic entry see Field 5G. W91-01213

**USE OF A COMPARTMENTAL MODEL TO DEVELOP RULES FOR THE INTERPRETATION OF WATER QUALITY DATA.**

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering. For primary bibliographic entry see Field 5B. W91-01214

Evaluation, Processing and Publication—Group 7C

**WATER QUALITY INDEX FOR USE IN THE OPERATIONAL MANAGEMENT OF RIVER WATER QUALITY IN EUROPE.**  
Middlesex Polytechnic, Enfield (England).  
For primary bibliographic entry see Field 5G.  
W91-01215

**ASSESSMENT OF THE ONTARIO MINISTRY OF THE ENVIRONMENT PROTOCOLS FOR CONDUCTING DAPHNIA MAGNA ACUTE LETHAL TOXICITY TESTS WITH PULP AND PAPER MILL EFFLUENTS.**  
Pulp and Paper Research Inst. of Canada, Pointe Claire (Quebec).  
For primary bibliographic entry see Field 5C.  
W91-01266

**HYDROLOGICAL INFORMATION TRANSFER USING HOMS.**  
Institute of Hydrology, Wallingford (England).  
H. R. Oliver, and J. B. Miller.  
Journal of the Institution of Water and Environmental Management JIWM, Vol. 4, No. 3, p 265-267, June 1990. 1 fig, 1 tab, 5 ref.

Descriptors: \*Cooperatives, \*Data storage and retrieval, \*Hydrologic data collections, \*Information systems, \*Information transfer, \*International commissions, \*Organizations, \*Water resources institutes, Case studies, Computer programs, Developing countries, Technology, Water resources development, Water resources management.

In recent decades, hydrological science and its associated technology have made substantial progress, and significant contributions have been made in the development and management of water resources. The Hydrological Operational Multipurpose (HOMS) scheme of the World Meteorological Organization (WMO) consists of an international network for the transfer of packages of proven hydrological know-how, with particular emphasis on helping developing countries. More than one hundred HOMS centers worldwide produce and supply information components and handle requests for components for use in their own countries. These components can take many forms, e.g. sets of drawings for constructing hydrological equipment, reports describing hydrological procedures, and computer programs. Details are presented of the organization and operation of HOMS, together with example case studies to illustrate its successful use. HOMS can be of considerable benefit for water engineers and managers in developing countries. (VerNooy-PTT)  
W91-01274

**ANALYSIS OF RADON GAS CONCENTRATION PREDICTIONS USING OSCAR AND NEROS MONITORING DATA.**  
State Univ. of New York at Albany. Atmospheric Sciences Research Center.  
For primary bibliographic entry see Field 5B.  
W91-01285

**LOGNORMAL DISTRIBUTION OF RADON CONCENTRATION IN GROUND WATER.**  
Ecole Polytechnique, Montreal (Quebec).  
For primary bibliographic entry see Field 5B.  
W91-01294

**HYDROGEOLOGIC DATABASE FOR GROUND-WATER MODELING.**  
Groundwater Services, Inc., Houston, TX.  
C. J. Newell, L. P. Hopkins, and P. B. Bedient.  
Ground Water GRWAAP, Vol. 28, No. 5, p 703-714, September/October 1990. 9 ref, 7 tab, 17 ref, append.

Descriptors: \*Computer programs, \*Databases, \*Geohydrology, \*Groundwater movement, \*Hydrologic data collections, \*Model studies, Aquifers, Classification, Computers, Flow velocity, Groundwater data, Hydraulic conductivity, Hydraulic gradient, Land disposal, Monte Carlo method, Saturated flow, Seepage.

A new geohydrologic database, the HGDB, was developed from a national survey of National

Water Well Association (NWWA) members. The database contains general geohydrologic information from 400 field site investigations across the country, and detailed statistical summaries of five groundwater parameters: hydraulic conductivity, seepage velocity, hydraulic gradient, saturated thickness, depth to top of aquifer. The HGDB was developed to verify and expand statistical distributions used in a Monte Carlo groundwater model developed by EPA for land disposal regulation. The database structure is a unique application of the aquifer classification method used in the NWWA's DRASTIC system. Respondents were asked to classify their aquifers as one of 111 different DRASTIC geohydrologic settings, and 12 groupings of settings were analyzed to produce statistical distributions of geohydrologic data based on site geology and geomorphology. Three examples of geohydrologic groupings are: coastal beaches; alluvial basins, valleys and fans; and outwash settings. First, the HGDB results indicate that the EPA's distributions of seepage velocity and hydraulic conductivity used in the land disposal model are sound. These are the most important geohydrologic parameters in the model. The HGDB goes a step further and provides a set of statistical distributions that can be used to make the land disposal regulations more site-specific than the national approach now being used. Finally, the HGDB data can be used for general site characterization and for educational purposes. The database is available as a detailed written report and spreadsheet file from the American Petroleum Institute, and is contained in a graphical computerized decision support system for groundwater modeling called OASIS. The HGDB serves as a framework for organizing geohydrologic information from different site investigations and can be expanded easily beyond the 400 sites now in the database. (Author's abstract)  
W91-01298

**PROGRAM TO CALCULATE HYDRAULIC CONDUCTIVITY USING SLUG TEST DATA.**  
Idaho National Engineering Lab., Idaho Falls.  
A. Wylie, and T. R. Wood.  
Ground Water GRWAAP, Vol. 28, No. 5, p 783-786, September/October 1990. 4 fig, 1 tab, 7 ref.

Descriptors: \*Aquifer testing, \*Hydraulic conductivity, \*Pumping tests, \*Slug tests, \*Well testing, Computer programs, Data interpretation.

SLUGTST is a computer program which calculates hydraulic conductivity from data obtained during a slug test. An on-screen graphical display allows the user to view the data and make a rapid evaluation. During the execution of a slug test, the water level in a well is instantaneously raised or lowered and changes in the water level are monitored as it seeks an equilibrium position. SLUGTST a program written in TURBO BASIC for IBM-PC computers and compatibles, calculates hydraulic conductivity from data obtained during these tests. (Lantz-PTT)  
W91-01305

**PREDICTING BIOACCUMULATION POTENTIAL: A TEST OF A FUGACITY-BASED MODEL.**  
Environmental Research Lab.-Narragansett, Newport, OR. Mark O. Hatfield Marine Science Center.  
For primary bibliographic entry see Field 5B.  
W91-01316

**TIME SCALES AND VARIABILITY OF AREA-AVERAGED TROPICAL OCEANIC RAINFALL.**  
Texas A and M Univ., College Station. Dept. of Meteorology.  
For primary bibliographic entry see Field 2B.  
W91-01446

**SUPPORTING WORLD HYDROLOGY: ACTIVITIES OF INTERNATIONAL HYDROLOGICAL PROGRAMS.**  
World Meteorological Organization, Geneva (Switzerland). Dept. of Hydrology and Water Re-

sources.  
For primary bibliographic entry see Field 6E.  
W91-01457

**STOCHASTIC MODELS OF STREAMFLOW: SOME CASE STUDIES.**  
Indian Inst. of Science, Bangalore. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 2E.  
W91-01461

**REGIONALIZATION AND SPATIAL ESTIMATION OF ETHIOPIAN MEAN ANNUAL RAINFALL.**  
Lund Univ. (Sweden). Dept. of Physical Geography.  
For primary bibliographic entry see Field 2B.  
W91-01466

**PREDICTION MODEL FOR SNOWMELT, SNOW SURFACE TEMPERATURE AND FREEZING DEPTH USING A HEAT BALANCE METHOD.**  
Tohoku Univ., Sendai (Japan). Geophysical Inst.  
For primary bibliographic entry see Field 2C.  
W91-01469

**FURTHER EXPLORATORY EVALUATIONS OF GROSSVERSUCH IV USING HAILPAD DATA: ANALYSIS OF HAIL PATTERNS AND STRATIFICATION BY STORM TYPE FOR SEEDING EFFECT.**  
Groupeement National d'Etudes des Fleaux Atmospheriques, Aubiere, France.  
For primary bibliographic entry see Field 2B.  
W91-01471

**ALGORITHM FOR RETRIEVING WATER VAPOR PROFILES IN CLEAR AND CLOUDY ATMOSPHERES FROM 183 GHZ RADIOMETRIC MEASUREMENTS: SIMULATION STUDIES.**  
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. T. T. Wilheit.  
Journal of Applied Meteorology JAMOA, Vol. 29, No. 6, p 508-515, 1990. 6 fig, 1 tab, 11 ref.

Descriptors: \*Algorithms, \*Atmospheric water, \*Data interpretation, \*Radiometry, \*Remote sensing, \*Simulation analysis, \*Water vapor, Atmospheric circulation, Cloud physics, Clouds, Marine climates, Microwaves.

The latent heat represented by atmospheric water vapor is extremely important to the energetics of the Earth system. Future satellites (NOAA and DMSP) will carry microwave radiometers designed to measure the profile of water vapor globally. The problem of retrieving water vapor from the measurements is highly nonlinear even in clear atmospheres, and the addition of clouds only makes it more so. An algorithm has been developed which will retrieve water vapor profiles from microwave radiometric measurements even in the presence of clouds. Simulations with this algorithm show a vertical resolution on the order of 3 km; clouds are well handled in many circumstances. At low altitudes the performance is decidedly better over the ocean than over land backgrounds; above 5 km the background makes little difference. The most surprising result is that clouds can actually improve the vertical resolution of the retrieval. (Author's abstract)  
W91-01474

**CALIBRATION AND VALIDATION OF A MODEL OF NON-INTERACTIVE SOLUTE LEACHING IN A CLAY-LOAM ARABLE SOIL.**  
Edinburgh School of Agriculture (Scotland). Dept. of Soil Science.  
A. J. A. Vinten, and M. H. Redman.  
Journal of Soil Science JSSCAH, Vol. 41, No. 2, p 199-214, June 1990. 9 fig, 6 tab, 18 ref.

## Field 7—RESOURCES DATA

### Group 7C—Evaluation, Processing and Publication

Descriptors: \*Agricultural hydrology, \*Clays, \*Data interpretation, \*Fertilizers, \*Leaching, \*Loam, \*Model studies, \*Soil water, \*Solute transport, Agriculture, Arable soils, Calibrations, Fertilization, Model testing, Nitrogen, Permeability, Scotland, Soil science, Soil texture.

Conditions for arable farming in the southeast of Scotland are very variable because of the wide range of elevation, mean annual temperature, and annual effective precipitation. However, the rate of mineralization of nitrogen (N) during winter is low, and rather low carry-over of mineral N to spring occurs. Early application is vulnerable to leaching; thus the prediction of leaching of early spring fertilizer N is important so that later applications can be adjusted. A capacity-type approximate leaching model with a simple treatment of soil matrix permeability was tested, using field tracer experiments with  $\text{CaBr}_2$ , on hydrologically isolated plots. The model predictions are sensitive to the value of the soil matrix permeability factor, and four methods of estimating this parameter were evaluated: (1) using a calibration based on soil texture; (2) least-squares fitting of the model to successive neutron probe measurements of the water content profile; (3) least-squares fitting to daily drainage outflow; and (4) least-squares fitting to cumulative drainage outflow. The best independent method (method 3) led to a slight (20-30%) under-prediction of leaching losses for two of the four experiments, but in one experiment leaching was much less than predicted. As a management model the approach seems promising but more attention needs to be paid to estimation of the value and variability of the permeability parameter. The convective-dispersion equation, using steady-state assumptions and a fitted dispersion length, gave as good a prediction of cumulative leaching losses as the approximate model. (Fish-PTT)  
W91-01477

**DEVELOPMENT, CALIBRATION AND FIELD TESTING OF A SOIL LOSS AND A RUNOFF MODEL DERIVED FROM A SMALL-SCALE PHYSICAL SIMULATION OF THE EROSION ENVIRONMENT ON ARABLE LAND IN ZIMBABWE.**  
Institute of Agricultural Engineering, Harare (Zimbabwe).  
For primary bibliographic entry see Field 2J.  
W91-01478

**MODEL FOR WATER DISTRIBUTION SYSTEM RELIABILITY.**  
Texas Univ. at Austin. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5F.  
W91-01495

**SOLVING GROUNDWATER FLOW PROBLEMS BY CONJUGATE-GRADIENT METHODS AND THE STRONGLY IMPLICIT PROCEDURE.**  
Geological Survey, Lakewood, CO.  
For primary bibliographic entry see Field 2F.  
W91-01515

**INVERSE SOLUTION FOR ONE-DIMENSIONAL INFILTRATION, AND THE RATIO  $A/K_1$ .**  
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.  
For primary bibliographic entry see Field 2G.  
W91-01519

**MEAN SQUARE ERROR OF REGRESSION-BASED CONSTITUENT TRANSPORT ESTIMATES.**  
Geological Survey, Reston, VA.  
For primary bibliographic entry see Field 5B.  
W91-01522

**PRACTICAL ASPECTS OF LOW-FLOW FREQUENCY ANALYSIS.**  
Melbourne Univ., Parkville (Australia). Dept. of Civil and Agricultural Engineering.

For primary bibliographic entry see Field 2E.  
W91-01529

**STOCHASTIC ANALYSIS OF UNSATURATED FLOW: ONE-DIMENSIONAL MONTE CARLO SIMULATIONS AND COMPARISONS WITH SPECTRAL PERTURBATION ANALYSIS AND FIELD OBSERVATIONS.**  
California Univ., Davis. Dept. of Land, Air and Water Resources.  
For primary bibliographic entry see Field 2G.  
W91-01536

**FOURIER DOMAIN SHAPE ANALYSIS METHODS: A BRIEF REVIEW AND AN ILLUSTRATIVE APPLICATION TO RAINFALL AREA EVOLUTION.**  
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.  
For primary bibliographic entry see Field 2B.  
W91-01537

**DEPRESSIONAL STORAGE FOR MARKOV-GAUSSIAN SURFACES.**  
National Soil Erosion Lab., West Lafayette, IN.  
For primary bibliographic entry see Field 2J.  
W91-01539

**PRIORITIZING FLOW ALTERNATIVES FOR SOCIAL OBJECTIVES.**  
Colorado State Univ., Fort Collins. Water Resources Research Inst.  
For primary bibliographic entry see Field 6G.  
W91-01552

**MODELING TO GENERATE RECREATIONAL ALTERNATIVES.**  
Colorado State Univ., Fort Collins. Water Resources Research Inst.  
For primary bibliographic entry see Field 6D.  
W91-01553

**IMPLEMENTATION OF ON-LINE CONTROL SCHEME FOR CITY WATER SYSTEM.**  
Leicester Polytechnic (England). Water Control Unit.  
For primary bibliographic entry see Field 5F.  
W91-01559

**CLASSIFICATION OF ESTUARIES IN CHINA (IN CHINESE).**  
East China Normal Univ., Shanghai.  
For primary bibliographic entry see Field 2L.  
W91-01570

**TWO-DIMENSIONAL NUMERICAL CALCULATION OF RESIDUAL CURRENT AND SALINITY AT THE CHANGJIANG RIVER ESTUARY (IN CHINESE).**  
Academia Sinica, Qingdao (China). Inst. of Oceanology.  
For primary bibliographic entry see Field 2L.  
W91-01578

**NEW EQUATION FOR THE ATMOSPHERIC ENERGY BUDGET (EINE NEUE GLEICHUNG FÜR DIE ATMOSPHÄERISCHEN ENERGIE-HAUSHALTE).**  
Vienna Univ. (Austria). Inst. fuer Meteorologie und Geophysik.  
For primary bibliographic entry see Field 2B.  
W91-01581

**CHANGEABLE WEATHER-A CHAOTIC PHENOMENON TRIGGERED OFF BY MESOSCALE PRECIPITATION-EDDIES (WETTERLAUNEN ALS CHAOTISCHE MESO-SKALIGE STRUKTUREN).**  
Vienna Univ. (Austria). Inst. fuer Meteorologie und Geophysik.  
For primary bibliographic entry see Field 2B.  
W91-01582

**EXTREME, SINGULAR AND COHERENT PRECIPITATION IN THE CATCHMENT BASIN OF THE UPPER INN RIVER (EXTREME, SINGULARE UND KOHAERENTE NIEDERSCHLÄGE IM GEBIET DES AFLINEN INN).**  
For primary bibliographic entry see Field 2B.  
W91-01583

**DELAYED DEVELOPMENT OF BACTERIOPLANKTON WITH RESPECT TO PHYTOPLANKTON: A CLUE FOR UNDERSTANDING THEIR TROPHIC RELATIONSHIPS.**  
Universite Libre de Bruxelles (Belgium). Groupe de Microbiologie des Milieux Aquatiques.  
For primary bibliographic entry see Field 2L.  
W91-01609

**MODELLING SEASONAL CHANGES OF EPIPLANKTONIC BACTERIA ON THE BASIS OF PHYTO- AND ZOOPLANKTON DYNAMICS.**  
South Bohemian Biological Centre, Ceske Budejovice (Czechoslovakia).  
For primary bibliographic entry see Field 2H.  
W91-01612

**ENTRAINMENT AND MIXING PROCESSES AS RELATED TO DROPLET GROWTH IN WARM MIDLATITUDE AND TROPICAL CLOUDS.**  
Centre National de la Recherche Scientifique, CRPA, Magny les Hameaux, France.  
For primary bibliographic entry see Field 2B.  
W91-01657

**USE OF DAILY VALUES OF SURFACE PARAMETERS AT DURBAN AND CAPE TOWN TO DETERMINE THE PRECIPITABLE WATER CONTENT OF THE ATMOSPHERE.**  
Natal Univ., Pietermaritzburg (South Africa). Dept. of Geography.  
For primary bibliographic entry see Field 2B.  
W91-01660

**NONLINEAR SOLUTION OF AGGRADATION AND DEGRADATION IN CHANNELS.**  
Detroit Water and Sewerage Dept., MI.  
For primary bibliographic entry see Field 2J.  
W91-01668

**MEASURING AND MODELING VARIATIONS IN DISTRIBUTION SYSTEM WATER QUALITY.**  
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.  
For primary bibliographic entry see Field 5F.  
W91-01751

**FLOCCULATION IN TURBULENT FLOW: MEASUREMENT AND MODELING OF PARTICLE SIZE DISTRIBUTIONS.**  
Pittsburgh Univ., PA. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5F.  
W91-01752

**SOIL CLEAN UP BY IN-SITU AERATION: V. VAPOR STRIPPING FROM FRACTURED BEDROCK.**  
Vanderbilt Univ., Nashville, TN. Dept. of Chemistry.  
For primary bibliographic entry see Field 5G.  
W91-01756

**GEOELECTRICAL INVESTIGATION FOR GROUND WATER IN CRYSTALLINE TERRAINS OF CENTRAL BAHIA, BRAZIL.**  
Universidade Federal do Rio Grande do Norte, Natal (Brazil). Dept. de Fisica.  
For primary bibliographic entry see Field 2F.  
W91-01780

Evaluation, Processing and Publication—Group 7C

**ELUCIDATING GROUND-WATER FLOW PATHS IN A DESERT TERRANE BY GEO-CHEMICAL METHODS.**  
Purdue Univ., Lafayette, IN. Dept. of Earth and Atmospheric Sciences.  
For primary bibliographic entry see Field 2F.  
W91-01784

**ESTIMATING THE VARIATION OF BUOY WIND AND WAVE DATA BIASES.**  
Atmospheric Environment Service, Downsview (Ontario).  
For primary bibliographic entry see Field 2H.  
W91-01797

**EMPIRICAL EVIDENCE FOR DIFFERENCES AMONG METHODS FOR CALCULATING SECONDARY PRODUCTION.**  
Montreal Univ. (Quebec). Dept. of Biological Sciences.  
C. Plante, and J. A. Downing.  
Journal of the North American Benthological Society JNASEC, Vol. 9, No. 1, p 9-16, March 1990. 2 fig, 3 tab, 40 ref.

Descriptors: \*Aquatic environment, \*Secondary productivity, \*Statistical analysis, \*Statistical methods, \*Statistics, Aquatic life, Benthos, Calculation methods, Cohort production interval, Ecosystems, Mathematical studies, Population dynamics, Precision.

The hypothesis that different secondary production estimation methods yield unbiased and equally precise estimates was tested using published data from 66 benthic invertebrate populations from lentic habitats. Tests are performed by Kruskal-Wallis one-way analysis of the residuals of a published empirical equation accounting for the important covariables biomass, body-mass, and water temperature. The data set analyzed came from 22 different ecosystems spanning a range of production from 0.03 to 66.40 g dry mass/sq m/yr, a range of mean annual biomass from 0.002 to 10 g dry mass/sq m, a range of body size from 0.01 micrograms to 60 mg dry mass and were found in environments with average annual surface water temperatures ranging from 4 to 18 deg. Of these estimates, 26 were made with the size-frequency technique, 20 were made with the Allen curve or growth increment summation methods, and 20 were made with the instantaneous growth technique. While no method was found to be significantly biased, the size-frequency method was less precise than the Allen curve, growth increment summation or instantaneous growth methods, yielding estimates about three times farther from the probable production values than other methods. Imprecision of inferred cohort production interval (CPI) is suggested as one source of error. (Author's abstract)  
W91-01808

**PERSPECTIVE ON AMERICA'S VANISHING STREAMS.**  
Alabama Univ., University. Dept. of Biology.  
For primary bibliographic entry see Field 6G.  
W91-01812

**DEVELOPMENT OF AN EXPERT SYSTEM EMBEDDING PATTERN RECOGNITION TECHNIQUE FOR GROUNDWATER POLLUTION SOURCE IDENTIFICATION.**  
California Univ., Davis. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5B.  
W91-01825

**WATER RESOURCES DATA FOR NEW MEXICO, WATER YEAR 1989.**  
Geological Survey, Albuquerque, NM. Water Resources Div.  
J. P. Borland, R. K. DeWees, R. L. McCracken, R. L. Lepp, and D. Ortiz.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-252040. Price codes: A19 in paper copy, A03 in microfiche. USGS-Water Data Report-NM-89-1. USGS/

WRD/HD-90/276, April 1990. 426p. Prepared in cooperation with the State of New Mexico and with other agencies.

Descriptors: \*Hydrologic data, \*New Mexico, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water-resources data for the 1989 water year for New Mexico consist of records of discharge and water quality of streams; stage, contents and water quality of lakes and reservoirs; and water levels and water quality in wells and springs. This report contains discharge records for 166 gaging stations; stage and contents for 26 lakes and reservoirs; water quality for 56 gaging stations and 84 wells; and water levels at 104 observation wells. Also included are 108 crest-stage partial-record stations. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. Also, two seepage investigations are published this year. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in New Mexico. (See also W90-06444) (USGS)  
W91-01828

**WATER RESOURCES DATA FOR NEBRASKA, WATER YEAR 1989.**  
Geological Survey, Lincoln, NE. Water Resources Div.  
J. A. Boohar, C. G. Hoy, and M. J. Ellis.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-251893. Price codes: A19 in paper copy, A03 in microfiche. USGS-Water Data Report-NE-89-1. USGS/WRD/HD-90/268, April 1990. 437p. Prepared in cooperation with the State of Nebraska and with other agencies.

Descriptors: \*Groundwater, \*Hydrologic data, \*Nebraska, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water-resources data for the 1989 water year for Nebraska consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water quality in wells. This report contains discharge records for 160 streamflow gaging stations, 12 partial-record or miscellaneous streamflow stations, and 5 crest-stage, partial-record streamflow stations; stage and content records for 11 lakes and reservoirs; water quality records for 38 streamflow stations, 8 ungaged stream-sites, and 159 wells; and water level records for 55 observation wells. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Nebraska. (See also W90-06429) (USGS)  
W91-01829

**WATER RESOURCES DATA FOR OREGON, WATER YEAR 1989, VOLUME 1. EASTERN OREGON.**  
Geological Survey, Portland, OR. Water Resources Div.  
L. E. Hubbard, R. L. Moffatt, T. A. Herrett, R. L. Kraus, and G. P. Ruppert.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-251885. Price codes: A10 in paper copy, A02 in microfiche. USGS-Water Data Report-OR-89-1. USGS/WRD/HD-90/287, May 1990. 197p. Prepared in cooperation with the State of Oregon and with other agencies.

Descriptors: \*Hydrologic data, \*Oregon, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Lakes, Reservoirs, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water-resources data for the 1989 water year for Oregon consists of records of stage, discharge, and

water quality of streams; and stage, contents, and water quality of lakes and reservoirs. This report, in two volumes, contains discharge records for 251 gaging stations; stage only records for 7 gaging stations; stage and contents for 39 lakes and reservoirs; water quality for 43 stations, and water quality for 3 precipitation stations. Also included are 5 crest-stage, partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oregon. (See also W90-07847) (USGS)  
W91-01830

**EVALUATION OF THREE ELECTRONIC REPORT PROCESSING SYSTEMS FOR PREPARING HYDROLOGIC REPORTS OF THE U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION.**  
Geological Survey, Reston, VA. Water Resources Div.  
For primary bibliographic entry see Field 10C.  
W91-01832

**GROUND-WATER FLOW IN THE GULF COAST AQUIFER SYSTEMS, SOUTH-CENTRAL UNITED STATES—A PRELIMINARY ANALYSIS.**  
Geological Survey, Austin, TX. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01838

**ASSESSMENT OF HYDROLOGIC AND HYDROGEOLOGIC DATA AT CAMP LEJEUNE MARINE CORPS BASE, NORTH CAROLINA.**  
Geological Survey, Raleigh, NC. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01840

**HYDROGEOLOGY OF AQUIFERS IN CRETACEOUS AND YOUNGER ROCKS IN THE VICINITY OF ONSLOW AND SOUTHERN JONES COUNTIES, NORTH CAROLINA.**  
Geological Survey, Raleigh, NC. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01841

**HYDROGEOLOGIC, WATER-LEVEL, AND WATER-QUALITY DATA FROM MONITORING WELLS AT THE U.S. MARINE CORPS AIR STATION, CHERRY POINT, NORTH CAROLINA.**  
Geological Survey, Raleigh, NC. Water Resources Div.  
For primary bibliographic entry see Field 5B.  
W91-01844

**U.S. GEOLOGICAL SURVEY NATIONAL COMPUTER TECHNOLOGY MEETING: PROGRAM AND ABSTRACTS, MAY 7-11, 1990.**  
Geological Survey, Nashville, TN. Water Resources Div.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 90-161, April 1190. 56p. B. H. Balthrop, E. G. Baker (compilers).

Descriptors: \*Computers, \*Hydrologic application, \*Information systems, \*US Geological Survey, Databases, Geographic information systems, National water information systems, System administration.

Computer-related information from all Divisions of the U.S. Geological Survey are discussed in this compilation of abstracts. Some of the topics addressed are system administration; distributed information systems and data bases, both current (1990) and proposed; hydrologic applications; national water information systems; geographic infor-

## Field 7—RESOURCES DATA

### Group 7C—Evaluation, Processing and Publication

mation systems applications and techniques. The report contains some of the abstracts that were presented at the National Computer Technology Meeting that was held in May 1990. The meeting was sponsored by the Water Resources Division and was attended by more than 200 technical and managerial personnel representing all the Divisions of the U.S. Geological Survey. (USGS)  
W91-01848

**GEOHYDROLOGIC CHARACTERISTICS AND SIMULATED RESPONSE TO PUMPING STRESSES IN THE SPARTA AQUIFER IN EAST-CENTRAL ARKANSAS.**  
Geological Survey, Little Rock, AR. Water Resources Div.  
For primary bibliographic entry see Field 2F.  
W91-01854

**WATER RESOURCES DATA FOR IOWA, WATER YEAR 1989.**  
Geological Survey, Iowa City, IA. Water Resources Div.  
D. J. O'Connell, M. J. Liszewski, R. B. Lambert, and W. J. Matthes.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-222423/AS. Price codes: A18 in paper copy, A03 in microfiche. USGS Water Data Report IA-89-1. USGS/WRD/HD-90/256, 1989. 399p. Prepared in cooperation with the Iowa Department of Natural Resources (Geological Survey Bureau) and other agencies.

Descriptors: \*Groundwater, \*Hydrologic data, \*Iowa, \*Surface water, \*Water quality, Chemical analysis, Data collections, Flow rates, Gaging stations, Groundwater level, Lakes, Reservoirs, Sampling sites, Sediments, Streamflow, Temperature, Water, Water analysis, Water level.

Water resources data for the 1989 water year for Iowa consist of record of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; groundwater levels and water quality of groundwater wells. This report contains records of water discharge for 117 stream-gaging stations; stage or contents for 8 lakes and reservoirs; water quality for 6 stream-gaging stations; sediment records for 10 stream-gaging stations; water levels for 185 observation wells; and chemical analyses for the 135 municipal wells. Also included are 113 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous discharge measurements and miscellaneous water-quality analyses. (USGS)  
W91-01856

**WATER RESOURCES DATA FOR WEST VIRGINIA, WATER YEAR 1988.**  
Geological Survey, Charleston, WV. Water Resources Div.  
S. M. Ward, J. A. Macy, F. M. Taylor, and G. M. Ferrell.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-222589. Price codes: A09 in paper copy, A02 in microfiche. USGS Water Data Report WV-88-1. USGS/WRD/HD-90/248, 1990. 185p. Prepared in cooperation with the State of West Virginia and other agencies.

Descriptors: \*Groundwater, \*Hydrologic data, \*Surface water, \*Water quality, \*West Virginia, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1988 water year for West Virginia consist of records of stage, discharge, and water quality of streams; contents of reservoirs; and water levels of observation wells. This report contains discharge records for 79 stream-gaging stations; stage only records for 7 gaging stations, and 2 crest-stage partial-record stations; (2) change in contents for 1 reservoir; (3) water quality records for 15 streamflow-gaging stations; and (4) water level records for 30 observa-

tion wells. Locations of these sites are shown. Additional water data were collected at various sites, not involved in the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in West Virginia. (USGS)  
W91-01858

**WATER RESOURCES DATA FOR MICHIGAN, WATER YEAR 1989.**  
Geological Survey, Lansing, MI. Water Resources Div.  
S. P. Blumer, J. C. Failing, W. W. Larson, C. R. Whited, and R. L. LeuVoy.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-230947/AS. Price codes: A13 in paper copy, A02 in microfiche. USGS Water Data Report MI-89-1. USGS/WRD/HD-90/255, 1990. 283p. Prepared in cooperation with the State of Michigan and with other agencies.

Descriptors: \*Groundwater, \*Hydrologic data, \*Michigan, \*Surface water, \*Water quality, Chemical analysis, Flow rates, Gaging stations, Sampling sites, Sediments, Water analysis, Water level, Water temperature.

Water resources data for the 1989 water year for Michigan consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and water levels and water temperature of groundwater. This report contains discharge records for 145 streamflow-gaging stations; stage only records for 13 lake-gaging stations; stage and contents for 5 lakes and reservoirs; water quality records for 21 streamflow-gaging stations; water level records for 51 observation wells; and water temperature records for 4 observation wells. Also included are 48 crest-stage partial record stations and 8 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data collection program. Miscellaneous data were collected at 62 measuring sites and 10 water quality sampling sites. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State, Local and Federal agencies in Michigan. (See also W90-05242) (USGS)  
W91-01864

**GROUND-WATER LEVELS, SPRINGS 1985, AND GROUND-WATER LEVEL CHANGES, SPRING 1983 TO SPRING 1985, IN THREE BASALT UNITS UNDERLYING THE COLUMBIA PLATEAU, WASHINGTON AND OREGON.**  
Geological Survey, Tacoma, WA. Water Resources Div.  
R. C. Lane, and K. J. Whiteman.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4018, 1989. 4 sheets, 4 fig, 20 ref.

Descriptors: \*Aquifer systems, \*Columbia Plateau, \*Geohydrology, \*Geologic units, \*Groundwater movement, \*Maps, \*Oregon, \*Washington, Columbia Basin Irrigation Project, Wanapum Basalt, Water resources data.

Groundwater level contour maps for three basalt units of the Columbia Plateau regional aquifer system were constructed by using water levels measured in 1,105 wells during 1985. These measurements then were compared with similar measurements from spring 1983 to assess the changes in groundwater levels over the 2-year period for each of the basalt units. Configuration of the groundwater contours and water level changes reflect (1) recharge and discharge; (2) hydraulic conductivity; (3) use of imported surface water for irrigation; and (4) pumping of groundwater. The movement of groundwater within each basalt unit is controlled mainly by the major rivers, streams, and coalesces, whereas variations in flow directions between units are related to the occurrence, extent, and hydraulic conductivity of the basalt units and

sedimentary interbeds and to differences in the amounts of recharge to each unit. (USGS)  
W91-01868

### MODELLING SOIL WATER SUPPLY TO CROPS.

Wye Coll., Ashford (England). Dept. of Agriculture, Horticulture and the Environment.  
For primary bibliographic entry see Field 2G.  
W91-01869

### INTERPRETATION OF METAL CONCENTRATIONS IN ESTUARINE SEDIMENTS OF FLORIDA USING ALUMINUM AS A REFERENCE ELEMENT.

Florida State Dept. of Environmental Regulation, Tallahassee.  
For primary bibliographic entry see Field 2L.  
W91-01898

### SIMULATION MODEL OF WATER DEPTH IN MANGROVE BASIN FORESTS.

Collier Mosquito Control District, Naples, FL.  
For primary bibliographic entry see Field 2L.  
W91-01899

### APPLICATION OF MULTIVARIATE ANALYSIS FOR CHARACTERIZATION OF ORGANIC COMPOUNDS FROM URBAN RUNOFF.

Universidad Politecnica de Madrid (Spain). Escuela Tecnica Superior de Ingenieros de Caminos.  
For primary bibliographic entry see Field 5A.  
W91-02004

## 8. ENGINEERING WORKS

### 8A. Structures

### INVESTIGATION INTO THE PERFORMANCE CHARACTERISTICS OF BOUNDARY BOXES SUBJECTED TO VERTICAL LOADING.

Loughborough Univ. of Technology (England). Dept. of Civil Engineering.  
For primary bibliographic entry see Field 8B.  
W91-01269

### DESIGN OF ROCK SLOPES IN SOVIET HYDROPOWER CONSTRUCTION PRACTICE.

V. I. Reznikova, and V. I. Rechitskii.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p 669-674, June 1990. 5 fig, 1 tab, 4 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 12, p 4-8, December 1989.

Descriptors: \*Construction methods, \*Dam construction, \*Engineering geology, \*Hydroelectric plants, \*Rock mechanics, \*Slope stability, \*Blasting, \*Drilling, \*Mathematical analysis, \*Mathematical studies, \*Shear stress, \*Structural engineering, USSR.

Since 1970, the All-Union Planning, Surveying, and Scientific Research Institute (Gidroproekt) has been calculating the stability of natural slopes and rock slopes of foundation pits, canals and other structures of hydroelectric stations and pumped-storage stations. In all, the stability of slopes with heights of 15-125 m at 20 Soviet hydropower facilities were analyzed. The most widely-used methods for calculation of rock slope stability were the deficit forces method and the method of shear along a plane surface. The form of the sliding limit surface depended on the fracture character of the mass, topography and the kinematic failure possibility. Stability was calculated mainly as a two-dimensional problem, since long slopes in which the effect of side surfaces could be neglected occurred in most cases. The purpose of these calculations included not only a determination of the slope stability factor for given parameters of fracturing and shear strength, but also an evaluation of the effect of the latter on stability. Analysis of the stability of artificial slopes proceeded as follows: on the basis of a model of rock mass fracturing constructed by engineering geologists, a number of

possible sliding surfaces were outlined and the stability of the rock slope with an initial steepness (contour) value was calculated. Generally, an iterative cycle of stability calculations was carried out for different values of the dip angles of the shear-dangerous fractures and for the purpose of finding the rock mass region with a minimum value of the stability factor  $K$ . If  $K$  was greater than the standard value  $K_s$ , the contour of the future slope was adjusted steeper, otherwise a more gentle slope was recommended or a variant of its stabilization was calculated. Design-related failures of masses were not observed in any of the designed slopes. The conditions for, and the parameters of, drilling and blasting operations have a noticeable effect on slope stability and angle, indicating the need for thorough development and rigorous observance of drilling and blasting operation plans. At a number of hydropower facilities, detailed stability calculations made it possible to eliminate costly engineering measures and reduce project costs. (Hoskin-PTT)  
W91-01433

#### ANALYTICAL METHOD OF CALCULATING SLOPE STABILITY.

For primary bibliographic entry see Field 8D.  
W91-01434

#### HYDRAULIC CALCULATION OF OPEN GROINS WITH VARIABLE COVERAGE.

For primary bibliographic entry see Field 8B.  
W91-01435

#### SOME PARAMETERS OF A SPREADING FLOW BEYOND PIPE CONDUITS.

For primary bibliographic entry see Field 8B.  
W91-01437

#### IRREGULAR WAVE LOAD ON SLOPES OF STRUCTURES.

For primary bibliographic entry see Field 8B.  
W91-01438

#### POSSIBILITIES OF CONSTRUCTING HYDRO-ELECTRIC STATIONS: PUMPED STORAGE STATIONS IN ARMENIA.

For primary bibliographic entry see Field 8C.  
W91-01439

#### MONITORING HIGH CONCRETE DAMS DURING THEIR CONSTRUCTION AND SERVICE.

For primary bibliographic entry see Field 8F.  
W91-01440

#### MECHANISM OF THE OPENING OF THE CONCRETE-ROCK JOINT IN THE SAYANO-SHUSHENSKOE DAM.

For primary bibliographic entry see Field 8F.  
W91-01441

#### REINFORCEMENT OF IN-SERVICE RETAINING STRUCTURES.

O. D. Rubin, O. B. Lyapin, and V. E. Ni. *Hydrotechnical Construction HYCOAR*, Vol. 23, No. 12, p 720-725, June 1990, 4 fig, 1 tab, 6 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p 42-45, December 1989.

Descriptors: \*Concrete technology, \*Construction methods, \*Load testing, \*Retaining walls, \*Structural engineering, Construction joints, Locks, Mathematical analysis, Mathematical models, Mechanical engineering, Reinforced concrete, Structural models, Waterways.

For existing retaining structures, which exhibit deviations in performance from design premises, an effective reinforcement system should be developed to reduce active loads with a simultaneous increase in bearing capacity and a reduction in structure deformability. Experimental investigations of lightly reinforced concrete models of walls on a 1:8 scale (with respect to the lock walls of the

Moscow Canal) were performed. The structural components of the reinforcing system were an additional wall (metallic or reinforced-concrete in the form of sheet piling, wall in the ground) and inclined components (metallic or reinforced-concrete girders or cross pieces), which transmitted the load from the additional wall to the front face of the existing wall. The wall models were tested under a static short-term load applied in increments of 0.05 of the computed failing load,  $Q_c$ . Crack formation in the experimental wall was characterized by the formation and vigorous development of a crack along the construction joint of the second concrete lift and an inclined crack leading away from the joint under a load of 21.4 kN; the failing load was 25.68 kN; this was more than one and one-half times smaller than the  $Q_c$  value. The mounting of two planes of inclined yokes led to partial restoration of the wall's bearing capacity as compared with the computed  $Q_c$  value. Installation of an additional wall from which the external load is transmitted onto the concrete wall using two planes inclined at a 12 degree angle to the horizontal made it possible to reduce somewhat the width of the joint opening of the second concrete lift under a load of  $> 24.0$  kN as compared with tests performed without the additional wall. The data obtained for the increase in limiting load that can be taken up by the reinforced wall suggest a significant reduction in bending moments and an increase in the longitudinal (vertical) compressive forces due to transfer of external forces from the additional wall through the force components onto the concrete wall at an angle of  $\alpha = 38$  degrees to the horizontal. (Hoskin-PTT)  
W91-01442

#### PREDICTING WAVE FORMATION IN MOUNTAIN RESERVOIRS DURING LANDFALLS AND LANDSLIDES.

For primary bibliographic entry see Field 8B.  
W91-01443

#### UPGRADING ANTIQUE SEWERS.

Massachusetts Water Resources Authority, Boston.  
For primary bibliographic entry see Field 5B.  
W91-01484

#### GROUTING SLIP LINERS: THE NEW INSIDE STORY.

Halliburton Services, Houston, TX.  
For primary bibliographic entry see Field 5D.  
W91-01486

#### HYDRODYNAMIC PRESSURE ANALYSIS OF ARCH DAMS WITH T-COMplete FUNCTIONS.

Ohio State Univ., Columbus. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 8B.  
W91-01489

#### MONITORING THE STATE OF THE DAM OF THE SAYANO-SHUSHENSKOE HYDROELECTRIC STATION.

A. I. Efimenko, K. K. Kuz'min, and E. K. Aleksandrovskaya. *Hydrotechnical Construction HYCOAR*, Vol. 23, No. 10, p 573-577, April 1990, 3 fig, 5 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 15-18, October 1989.

Descriptors: \*Dam foundations, \*Hydraulic engineering, \*Hydraulic structures, \*Hydroelectric plants, \*Measuring instruments, \*Soviet Union, Dam stability, Foundation rocks, Monitoring, Piezometers, Stress analysis.

The Sayano-Shushenskoe (Soviet Union) dam is a unique hydraulic structure. Because high reliability demands are imposed on it. A considerable number of on-site observations and investigations are performed to monitor the reliable operation of the dam. The monitoring system includes geodetic, piezometric, and flow monitoring and measuring instruments (MMI) that were installed during construction of the dam, its components, and the rock

foundation, making it possible to observe the structure and evaluate its state at various stages of construction and filling of the reservoir. During current monitoring on the dam the main parameters characterizing the static behavior of the dam foundation system are evaluated: the total displacements (settlements, tilts, horizontal displacements), state of the rock-concrete contact; state of the horizontal joints between blocks, sections, and columns; cracking in the concrete; and the seepage pressure in the concrete and rock foundation. The results of long-term monitoring of the dam indicate a satisfactory state of the structure at all stages of filling the reservoir and correspondence of the values of the parameters being monitored on site to their design premises, with the exception of stresses near the downstream face. To obtain representative information it is necessary to provide in the design for routine correction of the layouts of the MMI, particularly embedded instruments. (Fish-PTT)  
W91-01541

#### INITIAL PERIOD OF OPERATION OF THE CHANNEL DAM OF THE KUREIKA HYDRO-ELECTRIC STATION.

Y. N. Mznikov, S. I. Panov, and N. A. Shakov. *Hydrotechnical Construction HYCOAR*, Vol. 23, No. 10, p 578-583, April 1990, 5 fig, 3 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 18-22, October 1989.

Descriptors: \*Cold weather construction, \*Dam construction, \*Dams, \*Hydraulic structures, \*Hydroelectric plants, \*Soviet Union, \*Stress analysis, Dam design, Deformation, Earth dams, Reservoirs, Rockfill dams, Temperature effects.

The harsh natural and climatic conditions and year-round operation of hydroelectric stations at low negative air temperatures cause substantial changes in temperature and moisture state (TMS) of materials being placed in earth-rock dams in the Far North of the Soviet Union. On-site and experimental investigations of the TMS and stress-strain state of the upstream shoulder during filling of the reservoir were carried out to predict deformations of the earth-rock dam of the Kureika hydroelectric station. The results of the 2-year on-site observations of the behavior of the earth-rock dam being constructed under conditions of the Far North during filling of the reservoir permit the following conclusions: (1) rapid temperature and deformation processes occurred in the frozen upstream shoulder of the dam during its primary subirrigation; (2) under unfavorable deformation conditions, the formation of cracks is possible and in these cases special designs providing static and seepage stability of the structures are necessary; (3) the calculated strength and deformation characteristics should be assigned differentially depending on the working conditions of dams in the initial operation period; (4) special consideration should be devoted to the size and deformability of the transition zones which perform the role of a buffer between the core and shoulders; (5) mined rock should be placed uniformly over the entire area in layers with compaction by heavy vibrating rollers; and (6) on-site observations of the TMS and deformations of the upstream shoulders should be performed during their construction and operation in order to refine the design parameters of dams being constructed in the Far North. (Fish-PTT)  
W91-01542

#### EFFECTIVE DESIGN OF FACINGS OF BLAST-FORMED DAMS.

Y. N. Kasatkin. *Hydrotechnical Construction HYCOAR*, Vol. 23, No. 10, p 601-605, April 1990, 4 fig, 1 tab, 5 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 34-36, October 1989.

Descriptors: \*Construction methods, \*Dam construction, \*Dam design, \*Rockfill dams, \*Slope stabilization, Asphalt, Hydraulic design, Porosity, Rock fill, USSR.

The slopes of rockfill and blast-formed dams often have unorganized heapings of stone, often in a

## Field 8—ENGINEERING WORKS

### Group 8A—Structures

loose state relative to the dam body. To prepare such a slope for a reinforced-concrete facing, it is necessary to carry out considerable crushing, leveling, and compaction of the stone. However, this work often need not be performed if the facing on such a dam is made of poured asphalt. The depth of penetration of asphalt under the effect of its own weight into the pores of the rockfill with one-time pouring is determined by an empirical relation. The larger the size of the rock and the higher its porosity, the deeper the penetration of asphalt into it during pouring. However, the rock must most often be covered several times, counting on its flow into the pores of the fill between pourings. The formation of the given facing is quite simple and consists of: crushing of large rocks on the slope with subsequent grading; washing of the rock distributed over the slope not later than a day before covering it with asphalt by a pressure jet of clean water delivered to the slope through hoses; covering the rock with poured asphalt after its surface dries; holding the formed coating for a time during which the asphalt penetrates into the fill pores to the prescribed depth; a repeated leveling and covering of the rock with poured asphalt. Using empirical relations, for a known fractional composition of the rock a composition of the asphalt mass can be selected such that its penetration into the fill pores will be optimal. Thus facings of rockfill and blast-formed dams of rock covered with poured asphalt are easily designed and easily made, which opens broad opportunities for their use. (Fish-PTT)  
W91-01547

#### CONCERNING THE PROBLEM OF ASSIGNING THE COMPOSITIONS OF STEEL FIBER-REINFORCED CONCRETES.

For primary bibliographic entry see Field 8F.  
W91-01549

#### MECHANICAL EQUIPMENT OF THE TASHLYK PUMPED-STORAGE HYDROELECTRIC STATION AND ALEKSANDROVKA HYDRO DEVELOPMENT OF THE SOUTHERN UKRAINE POWER COMPLEX.

For primary bibliographic entry see Field 8C.  
W91-01644

#### MECHANICAL EQUIPMENT OF THE VILYUI NO. 3 HYDROELECTRIC STATION.

For primary bibliographic entry see Field 8C.  
W91-01645

#### BEHAVIOR OF SOIL UNDER A BRIEF DYNAMIC LOAD.

For primary bibliographic entry see Field 8D.  
W91-01649

#### SEEPAGE IN EARTH DAMS IN TWO- AND THREE-DIMENSIONAL FORMULATIONS OF THE PROBLEM.

For primary bibliographic entry see Field 8D.  
W91-01650

#### GEODETIC PROBLEMS IN THE CONSTRUCTION OF HIGH CONCRETE DAMS.

D. M. Grachev.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p. 661-664, 1990. 4 fig. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 11, p. 36-38, November 1989.

Descriptors: \*Arch dams, \*Concrete dams, \*Dam construction, \*Dam design, \*Dams, \*Deformation, \*Geodesy, \*Gravity dams, \*Hydraulic structures, \*Soviet Union, Dam foundations, Dam stability, Gravity-arch dams, Hydraulic geometry.

A high-head dam under construction undergoes deformation under the water head, its own weight, and other factors. The dam shifts along the foundation, moves vertically, and tilts or bends. The deformations increase with an increase of the dam height and head of water, as a consequence the elements of the structure are noticeably displaced. Other discrepancies are then noted between the

constructed part of the dam and its overlying part, which is still to be constructed. Discrepancies are also noted while performing geodetic location work for the overlying concrete levels. In designing high concrete dams of the arch and gravity-arch types it is necessary to provide special measures for geodetic construction provisions. A change to a system that involves location axes that move in space together with the dam under construction is recommended. This approach requires calculated predictions of the magnitude of deformations and data from on-site observations of the structure under construction. This approach was used for constructing the Sayano-Shushenskoe Dam. The points of the geodetic base, metal surface markers, were embedded every other section at a distance of 35 to 50 m from one another along the lower face of the dam around its perimeter (here final construction had to be put off until last). The coordinates of the points were determined by a geodimeter survey from points on the geodetic base of the construction site as of a certain date. The points of the geodetic base, once determined on the structure, are kept until the end of construction. They can then be raised from tier to tier along the plumb line. (Korn-PTT)  
W91-01652

#### HYDRAULIC JUMP IN TRIANGULAR CHANNEL.

Ecole Polytechnique Federale de Lausanne (Switzerland). Dept. de Genie Civil.  
For primary bibliographic entry see Field 8B.  
W91-01669

#### FLOW INDUCED PIPE VIBRATION DURING ITS SAGGING PROCESS.

East China Technical Univ. of Water Resources, Nanjing.  
For primary bibliographic entry see Field 8B.  
W91-01670

#### BEARSPAW DEVELOPMENT: DESIGN AND CONSTRUCTION OF A SIDE-CHANNEL OVERFLOW SPILLWAY.

For primary bibliographic entry see Field 8B.  
W91-01721

#### DAM RENOVATION: FROM INVESTIGATION TO REPAIR.

Bridgeport Hydraulic Co., CT.  
For primary bibliographic entry see Field 8F.  
W91-01748

#### CITY TACKLES MAJOR SANITARY SEWER REHABILITATION WITH NEW PROCESS.

For primary bibliographic entry see Field 5D.  
W91-01755

### 8B. Hydraulics

#### MODIFICATION OF COASTAL CURRENTS BY POWER PLANT INTAKE AND THERMAL DISCHARGE SYSTEMS.

Scripps Institution of Oceanography, La Jolla, CA. Center for Coastal Studies.  
M. H. S. Elwany, J. Reitzel, and M. R. Erdman.  
Coastal Engineering COENDE, Vol. 14, No. 4, p. 359-383, 17 fig. 1 tab. 13 ref. August 1990.

Descriptors: \*Electric powerplants, \*Environmental effects, \*Hydraulic profiles, \*Thermal pollution, \*Water currents, \*Water resources development, Cooling water, Flow profiles, Flow velocity, Hydraulic models, Nuclear powerplants.

Powerplant cooling systems that entrain large volumes of seawater in multiple discharge jets can produce changes in the local field of flow. A case history of observed flow modification is provided by dye studies and records of currents around the diffusers of the San Onofre Nuclear Generating Station (SONGS), which entrain a volume of flow on the order of 1000 cu m/s. Field observations of dilutions and velocities in the discharge plume agree well with the results of hydraulic modelling

of the diffuser system. Synoptic observations and long term statistical distributions of current speeds and directions show systematic patterns of altered flow around the diffusers that are more complex than the flow in the model because of interactions with flow modification by local beds of giant kelp. (Author's abstract)  
W91-01057

#### INVESTIGATION INTO THE PERFORMANCE CHARACTERISTICS OF BOUNDARY BOXES SUBJECTED TO VERTICAL LOADING.

Loughborough Univ. of Technology (England). Dept. of Civil Engineering.  
J. G. Dickens, and G. H. Mortimer.  
Journal of the Institution of Water and Environmental Management JIWMZ, Vol. 4, No. 3, p. 227-234. 8 fig. 5 ref. June 1990.

Descriptors: \*Check structures, \*Domestic water, \*Hydraulic loading, \*Load testing, \*Water metering, Backfill, Design criteria, Field tests, Vertical flow, Water boundary.

The results of a series of load tests carried out on a variety of designs of boundary boxes which are intended for use as stopcock/water meter chambers at domestic properties are presented. A test which was developed at Loughborough University to measure the performance, under load, of the complete boundary-box units in simulated site conditions was used. Three broad classifications of different design types were identified, namely rigid, flexible, and sliding; and the load displacement of each type are presented. The effects of rate of loading and different backfill conditions were considered, and conclusions were drawn on suitable performance specifications under load. A wide spread of performance within each design type was found. The units of the rigid design type were the only ones to approach the load-displacement performance of traditional clayware units, and not all rigid types would meet all criteria. Field tests on flexible boxes, which did not meet load criteria, correlated well with observed characteristics in sandbox tests. Sliding units also did not meet load criteria; but their load capacity was increased where quarry waste backfill was used. In conclusion, where vehicle loading is possible, a rigid type unit should be used. (VerNooy-PTT)  
W91-01269

#### ESTIMATION OF MANNING'S ROUGHNESS COEFFICIENT FOR BASIN AND BORDER IRRIGATION.

Bangladesh Agricultural Research Inst., Joydehpur.  
For primary bibliographic entry see Field 3F.  
W91-01406

#### GENESIS OF FREE HYDRAULIC JUMPS FOR BETTER MIXING.

Roorkee Univ. (India). Dept. of Civil Engineering.  
For primary bibliographic entry see Field 5F.  
W91-01421

#### HYDRAULIC CALCULATION OF OPEN GROINS WITH VARIABLE COVERAGE.

M. R. Bakiev, and N. P. Togunova.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p. 684-688, June 1990. 3 fig. 1 tab. 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 12, p. 14-17, December 1989.

Descriptors: \*Groins, \*Hydraulic design, \*Hydraulic models, Flow around objects, Flow models, Flow velocity, Hydraulic engineering, Mathematical analysis, Mathematical equations, Mathematical studies, River flow, Soviet Union.

Open groins are finding wide use in protection and regulation on rivers with a sand and loam channel. To eliminate the possibility of the flow bypassing the groins from the side of the bank being protected (from the root), they are made with variable coverage. The construction of such groins creates at their root in the upper pool a certain 'water cushion' protecting the structure from the flow

bypassing from the root, and the effectiveness of diminishing the velocities is higher than for ordinary open groins with a constant coverage, which can be achieved both with the arrangement of the elements of the groin in one row and several rows. The coverage factor is equal to the ratio of the area occupied by elements of the groin to the area of the channel being covered by the groin. The total coverage factor should not exceed 0.65, i.e., the limit after which the open groin begins to work as a closed one. Assigning the value of the coverage coefficient  $P \leq 0.65$ , the number of elements  $N$  necessary for the groin was determined. Experimental and theoretical investigations were conducted to study the work of open groins of the described design. An analysis of measurements of the level regime of the flow deformed by the open groin with a variable coverage showed that it undergoes changes mainly in the immediate vicinity of the groin, and on the remaining parts of the longitudinal and transverse velocity differences are small. An analysis of the velocity distribution in plan revealed the presence of zones with small and large transverse velocity differences, which was the basis for using certain principles of the theory of turbulent jets, in particular, the schemes of division of the flow into hydraulically homogeneous zones. The results of the investigations were used by the Central Asia Institute for Water Management in Cotton-Growing Regions when selecting variations for regulating the Amu Darya River channel in the region of the damless water intake to the Karshi main canal. (Hoskin-PTT) W91-01435

#### SOME PARAMETERS OF A SPREADING FLOW BEYOND PIPE CONDUITS.

G. D. Kekhtokhyan. Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p. 694-698, June 1990. 2 fig, 1 tab, 18 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p. 20-24, December 1989.

Descriptors: \*Flow characteristics, \*Flow models, \*Hydraulic models, \*Pipe flow, Flow profiles, Hydraulic design, Hydraulic engineering, Laboratory methods, Mathematical analysis, Mathematical equations, Mathematical studies, Open-channel profiles.

Pipe conduits are widely used as dam spillways, road culverts, diversion tunnels, offtake regulators, etc. A hydraulic analysis of these structures is not sufficiently accurate without appropriate consideration of the actual water flow conditions through them. Accordingly, the parameters were determined for a freely spreading rapid flow beyond pressure pipe conduits with consideration of the three-dimensional character of the flow. The problem was solved by an experiment performed on a laboratory model of a pipe outlet. During the experiment the form factor of the jet,  $N$ , was varied in the range 1.52-2.19 and the relative head was varied in the range 2.05-11.27. Free spreading was investigated in a wide lower pool with a three-dimensionality factor indicating unlimitedly-wide lower pool. The experimental investigation included a determination of the coordinates of the boundaries of the free spreading, depth, mean pressures on the bottom, and mean velocities over the axis of the spreading flow. The results of these investigations demonstrated that existing analytical and experimental methods of calculating the parameters of free spreading of a flow in the lower pool beyond pressure pipe conduits do not give acceptable results for  $N > 1$ , since the flow has a pronounced three-dimensional character. When evaluating the kinetics of the flow in the exit section with the use of its integral form, it is possible to eliminate the substantial effect of  $N$  on parameters of free spreading. The empirical relations obtained make it possible to calculate more accurately the parameters of free spreading of a rapid flow beyond pressure pipe outlets. (Hoskin-PTT) W91-01437

#### IRREGULAR WAVE LOAD ON SLOPES OF STRUCTURES.

V. S. Shaitan, and D. V. Morozova. Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p. 699-703, June 1990. 3 fig, 5 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p. 24-27, December 1989.

Descriptors: \*Hydraulic engineering, \*Hydraulic models, \*Sloping waves, \*Wave action, Hydraulic design, Mathematical analysis, Mathematical equations, Mathematical studies, Storms.

The chaotic characteristics of various irregular wind-wave processes can be reliably determined using functions having scientific and practical applicability. This was demonstrated by examining a non-erodible continuous slope, the most distinct manifestation of the group effect of wind systems on an obstacle. Under conditions of a random combination of complex factors and particular kinetics of breaking of dissimilar waves creating an unsteady hydraulic regime in the water-line region, the load acting on the slope requires a probabilistic interpretation in analogy with that used for wind-wave characteristics in the quasi-storm period. Replacement of the monochromatic principle of determining the wave load on slopes by a differentiated action with respect to probability of the process in a storm or in a representative quasi-steady system makes it possible to increase the technical and economic effectiveness of material expenditures in the construction and operation of objects of various types, purpose, operating conditions, service life, etc., and at the same time to ensure a high reliability of the structures. To study the new probabilistic regularities of the force effect of irregular waves on slopes under real storm conditions, permanent (several year) investigations were set up on several objects, which made it possible to collect numerous on-site data sets. Unlike a regular wave load, an irregular wave load depends explicitly on the steepness of the slope, with a tendency toward an increase of this effect on a more gentle slope than a decrease of the numerical value on the load on a steeper slope. The on-site data on irregular wave pressure and total load on slopes can be used on various water areas, since the integral distribution functions of the wave characteristics in their representative systems had a completely satisfactory convergence with analogous distribution functions characteristic for other water areas, including with the standard values used for a wide range of water bodies. (Hoskin-PTT) W91-01438

#### PREDICTING WAVE FORMATION IN MOUNTAIN RESERVOIRS DURING LANDFALLS AND LANDSLIDES.

T. L. Gvelesiani, B. N. Ostroverkh, G. Y. Dzindzhikhashvili, S. O. Eranosyan, and V. I. Reznikova. Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p. 725-730, June 1990. 5 fig, 10 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p. 46-49, December 1989.

Descriptors: \*Dam design, \*Dam failure, \*Hydraulic engineering, \*Landslides, \*Reservoirs, \*Wave formation, Geophysics, Mathematical analysis, Mathematical equations, Mathematical models, USSR, Wave height.

Wave formation as a result of landslides into closed pools, bays and fjords has recently attracted the attention of hydraulic engineers. Prediction of the parameters of landslide-induced waves is broken down into a series of problems, which are related to the different fields of continuum and fracture mechanics: determination of the stress-strain state and slope stability on the sides of the reservoir; the separation, movement and immersion of the separated mass in the water; the formation and propagation of waves on the surface of the water; and, the interaction between the waves and the retaining or shore structures. Analytic analysis of the first group of problems is based primarily on the theory of elasticity and plasticity and lies in the field of geomechanics. For the second group of problems, modification of the hydraulic model of a one-dimensional fluid flow is used to describe the rapid motion of large rubble masses. The last two groups of problems are investigated on the basis of methods of hydromechanics using computational geometric and kinematic parameters, as determined, respectively, as a result of solution of the previous problems, and as initial data (boundary

conditions). These methodologies were applied to the study of wave formation in the reservoir formed by the Getiksk hydraulic facility with a dam built of local materials (53 m high) on the Chichkhan River in the Armenian republic. The rate of wave formation in the reservoir is governed primarily by the volume of the landfall body and by the rate landfall immersion. A frictional model of the motion of a quasideformable landfall block along a plane surface (the shoreline slope and bottom of the reservoir) was used for a characteristic of the kinematic indicators of a landfall with a volume of ca. 1 million cu m. These calculations indicated that a wave that will top the crest of the dam can form during such a collapse. The design therefore specifies a 3-m increase in the dam's crest, and the construction of a wave-protection dike. (Hoskin-PTT) W91-01443

#### HYDRODYNAMIC PRESSURE ANALYSIS OF ARCH DAMS WITH T-COMPLET FUNCTIONS.

Ohio State Univ., Columbus. Dept. of Civil Engineering.

K. Sun, and F. C. Hadipriono. Journal of Engineering Mechanics (ASCE) JENMDT, Vol. 116, No. 9, p. 2054-2069, September 1990. 10 fig, 10 ref.

Descriptors: \*Arch dams, \*Hydraulic engineering, \*Hydrodynamics, \*Model studies, \*Water pressure, Boundary conditions, Canyons, Dam design, Numerical analysis, Stream banks.

The analysis of hydrodynamic pressure on arch dams is a practical yet complex engineering topic. To solve this problem numerically with the boundary element method (BEM), a semi-analytical and semi-numerical approach in the fluid domain may be used. The hydrodynamic pressure acting on the upstream face of arch dams has been explored by a special BEM based on the use of a complete and nonsingular set of Trefftz functions. The arch dam, bounded by a limited, arbitrary irregular part and an unlimited regular part of the river valley, was considered to be in an arbitrary shape, using this method, one can accurately model the compressibility of the water and the gravity waves on the water surface. Numerical examples illustrated the effects of the canyon shape and the bank angle from the symmetry axis. The hydrodynamic pressure on an arch dam will be reduced significantly by decreasing the value of the half-width on the dam bottom. The shape of the canyon slope has an important effect on the pressure for cross-canyon excitation, but it has little effect on upstream-downstream excitation. Comparisons with other numerical solutions show complete agreement. (Fish-PTT) W91-01489

#### DEVELOPMENT OF BED FEATURES.

Auckland Univ. (New Zealand). Dept. of Civil Engineering.

For primary bibliographic entry see Field 2J. W91-01491

#### MODELING EROSION OF SAND AND SILT BED RIVER.

Barnett Consultants, Hamilton (New Zealand).

For primary bibliographic entry see Field 2J. W91-01492

#### THREE-DIMENSIONAL COMPUTATION OF FLOW AND BED DEFORMATION.

Civil Engineering Research Inst., Sapporo (Japan).

For primary bibliographic entry see Field 2J. W91-01493

#### FLOW STABILITY AND FRICTION FACTOR IN ROUGH CHANNELS.

Politecnico di Torino (Italy). Inst. di Idraulica. M. Rosso, M. Schiara, and J. Berlamont. Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 9, p. 1109-1118, September 1990. 6 fig, 1 tab, 20 ref, append. NATO Grant

## Field 8—ENGINEERING WORKS

### Group 8B—Hydraulics

696/84.

Descriptors: \*Channel flow, \*Flow friction, \*Flow models, \*Froude number, \*Hydraulic properties, \*Model studies, \*Waves, Friction loss, Open-channel flow, Reynolds number, Uniform flow.

It is well known that in steep channels, the flow becomes unstable when the Froude number exceeds some critical value. Instead of obtaining uniform flow, a short distance from the channel inlet/waves of various lengths, amplitudes, and phase velocities appear. These waves, traveling downstream and occasionally overtaking each other, are called roll waves. The value of the friction factor in open channels in unstable flow conditions is affected by the Froude number. Some formulas for the calculation of the friction factor in unstable flow conditions have been suggested previously. After these formulas were checked for smooth channels, the formulas for rough channels were compared with measurements. The critical Froude number, which is presented as a function of the Reynolds number, the channel roughness, the vertical velocity distribution coefficient, and the channel width, is found to be an important parameter. A generalized formula computes the friction factor both in smooth and rough channels in unstable supercritical flow conditions. The experiments carried out confirm the increase of the friction factor in unstable flow in rough channels. (Author's abstract)

W91-01494

#### ADVECTION SIMULATION BY MINIMAX-CHARACTERISTICS METHOD.

Hong Kong Polytechnic, Kowloon. Dept. of Civil and Structural Engineering.  
C. W. Li.

Journal of Hydraulic Engineering (ASCE) JHEND8, Vol. 116, No. 9, p 1138-1144, September 1990. 3 fig, 10 ref.

Descriptors: \*Advection, \*Dispersion, \*Finite difference methods, \*Groundwater movement, \*Hydrodynamics, \*Model studies, Fourier analysis.

The advective transport of a scalar has been simulated by using the minimax-characteristics method, which is an explicit and efficient finite difference scheme derived from the local minimax approximation of the exact solution of the pure advection equation. Fourier mode analysis shows that the method is unconditionally stable, and produces relatively small celerity error and little amplitude dissipation. The scheme compares favorably with the other commonly used backward characteristics schemes: it is better than the scheme using quadratic interpolation (higher accuracy, approximately equal computational effort), and is better than the schemes using cubic interpolation (approximately equal accuracy, less computational effort); it is less accurate than the scheme using Hermite cubic interpolation, but requires only one-half the computational effort. By interpreting the scheme as a backward characteristics scheme with quadratic approximation of the exact solution over four nodes, the extension of the method in a split-operator approach for advection-dispersion and hydrodynamics modeling in two or three dimensions is straightforward. (Author's abstract)

W91-01496

#### CURRENT PROBLEMS AND PRACTICE OF ENGINEERING-GEOLOGICAL SURVEYS WHEN DESIGNING LARGE RESERVOIRS.

For primary bibliographic entry see Field 6G. W91-01545

#### EXPERIENCE IN USING DIGITAL VOLT-METERS IN THE SYSTEM MEASURING THE POOL LEVELS AND HEAD AT HYDROELECTRIC STATIONS.

For primary bibliographic entry see Field 8G. W91-01546

#### WHAT RESULTS WHEN THE BUILDING CODES ARE NOT OBSERVED.

E. S. Lyubashevskii, and V. Y. Martenson.

Hydrotechnical Construction HYCOAR, Vol. 23, No. 10, p 612-615, April 1990. 1 fig, 2 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 42-44, October 1989.

Descriptors: \*Building codes, \*Construction methods, \*Hydraulic design, \*Hydraulic engineering, \*Hydroelectric plants, Design criteria, Hydraulic gates, Installation, Maintenance, Mechanical equipment, Safety, Soviet Union.

In recent years the construction of hydropower plants in the Soviet Union has been carried out increasingly more often where the units are put into operation temporarily, i.e., long before completion of all construction and assembly works on the dam structures. According to the 'Standards for the Technological Design of Hydroelectric Stations,' the mechanical equipment intended for operation in the construction period should be designed according to the standards used for the operating period, which allows for operation of the mechanical equipment according to the temporary scheme with adjustments as the structure 'grows.' Ahead-of-schedule flooding of the pit deprives the operation of proper installation and start-up adjustments. Standards regulating the opening size of gates are often violated by designers of hydraulic structures. Nonsynchronized hoisting operations with cranes is the grossest violation of the 'Rules of the arrangement and safe operation of cranes, in which it is forbidden to raise and move a restrained load. The operating reliability of gates also depends on the installation and quality of concreting the embedded parts, which is not always satisfactory. Start-up and adjustment operations should be formulated and carried out according to requirements in newly developed guides (in place of the abolished sections of the building code). Before publication of the new guide ('Manufacture, installation, and acceptance of mechanical equipment of hydraulic structures'), all requirements of the building codes and standards of the technological design of hydrostations should be fulfilled by all participants in the creation of mechanical equipment and hydraulic structures. (Fish-PTT)

W91-01550

#### INVESTIGATION OF THE DIVERSION OUTLET OF THE KIRZAN HYDRO DEVELOPMENT.

G. L. Mazhbits, and V. N. Kurdyukov.

Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 628-631, 1990. 3 fig. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 12-14, November 1989.

Descriptors: \*Diversion structures, \*Hydraulic design, \*Hydraulic equipment, \*Hydraulic models, \*Hydraulic structures, \*Outlets, \*Soviet Union, Dams, Design criteria, Hydroelectric plants, Model studies, Reservoirs.

The diversion outlet of the Kirzan hydro development was investigated with a hydraulic model on a scale of 1:50. A check of the initial design variant of the outlet showed design imperfections. The originally designed diversion outlet consists of a three-bay intake, a pipe with a section of 8 x 8 m, and expanding outlet portal. The middle opening has a width of 8 m and the extreme ones 4 m each. The low-flow discharges pass through the three openings, and after reaching a reservoir level of 72 m, the extreme openings are covered by stoplogs and no longer operate. After flood waters recede and subsequent partial drawdown of the reservoir, the middle opening is also closed and the diversion outlet is taken out of further service. As a result of the experimental investigation on a hydraulic model, an improved design of the diversion outlet was obtained, which has practically the same construction volume and elements. When compared with the original variant it has several advantages. It has a higher discharge capacity at low levels and a lower capacity at high reservoir water levels. The new design provides an allowable maximum fall during damming of the river channel and it provides the maximum allowable discharge at the highest water level in the reservoir. The new diversion outlet guarantees a free flow in the pipes in the entire range of discharges and it has a better spreading and dissipation of the energy of the flow

in the lower pool. Finally, the new outlet design provides a 25% smaller depth of scouring in the lower pool and prevents local scouring of the tailwater channel in the immediate vicinity of the structure. (Korn-PTT)

W91-01646

#### EFFECT OF THE RIGA HYDROELECTRIC STATION ON THE CURRENT VELOCITY NEAR WHARVES OF THE RIGA COMMERCIAL SEAPORT.

G. Y. Segal, and E. L. Tsoneva.

Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 631-633, 1990. 2 fig. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 15-16, November 1989.

Descriptors: \*Channel erosion, \*Channel flow, \*Channel morphology, \*Channel scour, \*Dam effects, \*Hydroelectric plants, \*Hydrologic regime, \*Soviet Union, Channel improvement, Economic evaluation, Hydraulic design, Hydraulic equipment, Hydraulic machinery, Hydraulic structures, Hydroelectric power, Velocity.

The Riga commercial sea port (RCSP) is located at the mouth of the Daugava River. The operation of the Riga hydroelectric station (1974) completely changed the hydrological regime in the lower pool of the station, in which the port was located. A prediction of the transformation of the Daugava channel as a consequence of these changes was made by the Latvian Urban Planning Institute. These predictions were based on the technological regime of the planned hydrostation. The more than 10-year period of hydrostation operation showed that although operating as a peak-load station in a daily regulating regime with two releases, there are considerable differences from the design regime. The differences between the design and actual operating regime of the hydrostation led to a considerable deviation of channel deformation downstream from the station when compared with the prediction. The channel of the lower course of the river is composed mainly of medium-grained sands in the size range 0.25-0.50 mm. For these grains, the permissible bottom velocity does not exceed 0.25 m/sec. Actually, the velocities occurring during operation of all units of the Riga hydrostation are considerably higher. These high velocities are the main cause of the channel scouring. Large and costly hydrotechnical works will be required to prevent further dangerous deformations of the Daugava channel near the wharves of the RCSP. (Korn-PTT)

W91-01647

#### LOCAL ENERGY LOSSES IN TWO-COMPONENT PRESSURE FLOWS.

B. M. Levin, A. N. Lopatin, and V. F. Boiko.

Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 634-638, 1990. 1 fig, 1 tab, 17 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 16-19, November 1989.

Descriptors: \*Cavitation, \*Flow characteristics, \*Flow friction, \*Flow resistance, \*Head loss, \*Hydraulics, Agriculture, Flow equations, Hydraulic friction, Hydraulic transportation, Hydroelectric plants, Land reclamation, Multiphase flow, Slurries.

Systems of hydraulic transport of solid materials have presently become widespread in various areas of agriculture, hydrotechnical construction, industry, and land reclamation. Most developments and investigations of the two-phase flows associated with these hydraulic transport systems pertain mainly to a determination of their transporting capacity. Even less studied is the problem of determining the head losses of slurries due to local hydraulic resistances (in an abbreviated form, local losses). At the same time, local head losses in some cases make a substantial contribution to the calculation of hydraulic transport systems, and sometimes are the factor determining this calculation (e.g., the suction lines of systems, short slurry pipelines). Local losses during movement of slurries representing a mixture of water and solid material (mainly quartz sands) were investigated.

Along with this, mixtures of water with polymer additives (mainly polyacrylamide, PAA), which under certain conditions can considerably reduce hydraulic friction in a turbulent pressure flow were also investigated. The presence in two-component flows of a second component in the form of solid inclusions (with a particle size up to 25 nm) or polymer additives (reducing the linear head losses in uniform turbulent flows) does not affect the extent of local hydraulic resistances expressed in fractions of the velocity head of the mixture. This conclusion was indirectly confirmed by the discharge coefficients of contracting devices (flowmeters) and the cavitation characteristics of centrifugal pumps. (Korn-PTT)  
W91-01648

#### HYDRAULIC JUMP IN TRIANGULAR CHANNEL.

Ecole Polytechnique Federale de Lausanne (Switzerland). Dept. de Genie Civil.  
W. H. Hager, and R. Wanoschek.  
Journal of Hydraulic Research JHYRAF, Vol. 25, No. 5, p 549-564, 1987. 12 fig, 16 ref.

Descriptors: \*Hydraulic geometry, \*Hydraulic jump, \*Hydraulic properties, \*Open-channel flow, \*Spillways, \*Tailrace, Channel morphology, Energy dissipation, Froude number, Hydraulic structures, Momentum transfer, Tailwater, Turbulent flow.

The main features of hydraulic jumps in trapezoidal channels were analyzed. In particular, the hydraulic jump in channels with triangular cross-sections was examined experimentally. The results were compared with data collected in channels with rectangular cross-sections. Based upon the equality of mass, energy, and momentum transfer in the inflow section, the hydraulic and geometric properties of the two jumps were correlated. The sequent depth ratio in the triangular channel was significantly lower; therefore, the tailwater depth of a rectangular channel must be much higher. As a consequence, the relative energy dissipation of the jump in the triangular channel was much higher (typically 30%). The jump in a triangular channel was almost two times shorter than the corresponding jump in a rectangular channel. However, the volume of the jump was about 30% higher in the triangular channel; the ratio of jump volumes increased almost linearly with the Froude number. The surface width at the end of the jump was larger in a triangular channel; therefore, lateral space limitations may become important. The sensitivity of the hydraulic jump to slight discharge variations was lower in the triangular channel; consequently, the sensitivity of slight tailwater variations was higher. (Miller-PTT)  
W91-01669

#### FLOW INDUCED PIPE VIBRATION DURING ITS SAGGING PROCESS.

East China Technical Univ. of Water Resources, Nanjing.  
Y. Mao.  
Journal of Hydraulic Research JHYRAF, Vol. 25, No. 5, p 565-582, 1987. 19 fig, 1 tab, 10 ref.

Descriptors: \*Hydraulic engineering, \*Pipe flow, \*Pipelines, \*Scour, \*Vibrations, Damage, Erosion, Flow velocity, Hydraulic structures, Sagging.

Pipelines may be damaged by flow-induced vibration. Fatigue problems caused by pipe vibration have received much attention, but little consideration has been given to the impact of vibrating pipelines on their beds. The interaction between a vibrating pipe and an erodible bed was studied. Pipe vibration during sagging was emphasized. Bed scour below a pipeline is promoted by pipe vibration. If the scour hole below a pipeline is large enough, gravity and the flexibility of the pipeline can allow the pipe to sag into the scour hole. Flow velocity is an important factor in promoting vibration, but the eroded bed has a restrictive effect on vibration. The distance between the pipe and the bed is also important. The pipe state can be classified as (1) the pre-vibration stage, (2) the lock-in stage, or (3) the lock-out stage. For different pipe states, the amplitude response ten-

dencies during sagging of the pipe are quite different. When the pipe is in the lock-in stage and very close to the bottom of the scour hole, the pipe may vibrate with such an amplitude that it may be damaged due to its impact on the scour hole. (Author's abstract)  
W91-01670

#### COMPARISON BETWEEN MEASURED WAVE PROPERTIES AND SIMPLE WAVE HINDCASTING MODELS IN SHALLOW WATER.

North Carolina Univ. at Morehead City. Inst. of Marine Sciences.  
R. A. Luettich, and D. R. F. Harleman.  
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 299-308, 1990. 4 fig, 1 tab, 16 ref. U.S./Hungary Cooperative Science Program Grants INT-8112454 and INT-8411545 and NSF Grant ECE-8211525.

Descriptors: \*Lakes, \*Model studies, \*Sediment transport, \*Shallow water, \*Waves, Comparison studies, Fetch, Hungary, Lake Balaton, Wave height.

The U.S. Army Corps of Engineers has published two versions of a simple shallow-water wave hindcasting model that has the potential for predicting characteristic wave properties. Significant wave heights and wave periods obtained from field measurements in Lake Balaton, Hungary, were compared with the two versions of this model. The earlier version was found to give very good hindcasts of wave height but fell approximately 20% low on wave period. The later model was 15-20% above the earlier version for winds directed along the axis of the lake and therefore having relatively long fetches. For short fetches, results from the two model versions were nearly the same. (Author's abstract)  
W91-01671

#### ANALYTICAL ASYMPTOTIC SOLUTIONS FOR LONGITUDINAL DISPERSION WITH DEAD ZONES.

Contra Costa Water District, Concord, CA.  
R. A. Denton.  
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 309-329, 1990. 5 fig, 1 tab, 33 ref.

Descriptors: \*Dead zones, \*Dispersion, \*Mathematical analysis, \*Path of pollutants, \*Streamflow, Aris method of moments, Boundary conditions, Data interpretation, Mathematical studies, Rivers.

Longitudinal dispersion in rivers is the combined effect of the stretching of a dispersant cloud by differential advection and removal of the cross-sectional concentration gradients by cross-sectional mixing. Dispersant material can become temporarily trapped in separation or dead zones along the flow boundaries. Analytical solutions for the asymptotic behavior of two-dimensional flow with dead zones was obtained using the Aris method of moments. The spatial and temporal solutions demonstrated the relative contributions of main flow shear dispersion and dead zone trapping to the total rate of longitudinal dispersion. Steady-state equilibrium profile solutions for the variations in mass, centroid and variance over the flow cross-section were derived. While the centroid, variance and skew all increase linearly during the equilibrium period, the kurtosis increases quadratically, consistent with an eventual asymptote of the kurtosis coefficient to the Gaussian value of 3.0. (Author's abstract)  
W91-01672

#### KINEMATIC CASCADES: DERIVATION OF A GENERALIZED SHOCK FORMATION CRITERION.

Technische Univ., Vienna (Austria). Inst. fuer Hydraulik Gewasserkunde und Wasserwirtschaft.  
B. H. Schmid.  
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 331-340, 1990. 2 fig, 16 ref.

Descriptors: \*Hydraulic engineering, \*Kinematic wave theory, \*Overland flow, \*Rainfall-runoff relationships, \*Shock formation, Excess rainfall, In-

filtration, Mathematical analysis, Model studies, Ponding.

Practical use of the kinematic-wave concept in engineering applications of the hydraulics and hydrology of overland flow frequently requires an extension termed the 'kinematic cascade', which allows the approximation of natural ground surface by a series of planes. Shock formation may present problems in the course of kinematic cascade modeling. When choosing an adequate algorithm of solution, it is important to know beforehand whether discontinuities are to be expected. A generalized criterion including cases of time-dependent rates of rainfall excess was derived. Kinematic shock formation on a cascade of infiltrating planes was found to be strongly dependent on the ratio of respective ponding times. If a kinematic cascade comprises two planes with overland flow on the upper one starting earlier than on the lower one, a shock will occur as soon as the rate of rainfall excess related to the upper plane becomes nonzero. In all other cases the generalized shock-formation criterion accounting for time-dependent infiltration is more complicated. Three different types of shock were identified, two of which are relevant to the problem considered. Accordingly, the derived criterion consists of two cases, both of which must be checked in the course of practical application. (Miller-PTT)  
W91-01673

#### SCOURHOLE DEVELOPMENTS IN SHALLOW TAILWATER.

James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Civil and Systems Engineering.  
A. J. Johnston.  
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 341-354, 1990. 6 fig, 4 tab, 27 ref.

Descriptors: \*Erosion, \*Hydraulic structures, \*Scour, \*Tailwater, Experimental data, Hydraulic processes, Plane jet, Sediment transport, Shallow water.

An understanding of scour processes in areas where loose sediments are located near the foundations of hydraulic structures is normally required during analysis and design. The scourhole development of a plane jet entering shallow tailwater conditions was investigated. Through dimensional considerations and physical reasoning, the appropriate functional groups were identified. Experimental laboratory results were used to evaluate the functional relationships and show that in shallow conditions, the jet can produce three very different scourhole regimes. (1) For fairly small depth values, moderate bed offsets and small densimetric Froude numbers, a surface jet scourhole regime is likely where the jet is attached to the free surface. This scourhole is rarely observed in normal engineering applications. (2) For large depth values up to and beyond large offsets, a bed jet regime is observed where the jet is attached to the bed. This regime is the most commonly observed in engineering practice. (3) With moderate depths and moderate bed offsets, the jet flicks between boundaries. The period of this flicking cycle varies between 2 and 30 min and is dependent on tailwater depth. This transient regime has a number of important characteristics which need assessment in a number of engineering situations; for instance, the rate at which the scourhole depth increases is 40% (surface regime) and 70% (bed-surface regime) that of the bed regime. (Miller-PTT)  
W91-01674

#### MODELLING OF SANDWAVE EVOLUTION RESULTING FROM SUSPENDED AND BED LOAD TRANSPORT OF SEDIMENT.

Reading Univ. (England). Dept. of Meteorology.  
B. Johns, R. L. Soulsby, and T. J. Chesher.  
Journal of Hydraulic Research JHYRAF, Vol. 28, No. 4, p 355-374, 1990. 7 fig, 16 ref. Contract No. GR/E/09436.

Descriptors: \*Bed load, \*Channel morphology, \*Dunes, \*Model studies, \*Sand, \*Sediment transport, Coastal waters, England, Estuaries, Flumes,

## Field 8—ENGINEERING WORKS

### Group 8B—Hydraulics

Mathematical models, Sedimentation, Taw Estuary.

Bedforms are a common feature of sand-bedded rivers, estuaries and open sea areas. In addition to small-scale ripples, larger sandwaves (dunes) are found in most areas of strong sediment transport. A numerical model was used to determine changes in the bed morphology resulting from the bed load and suspended transport of sand. The ability of the model to predict mean and turbulent quantities and the suspended transport of sand was assessed by laboratory flume experiments and field observations. The model was then applied to investigate changes that may be expected to occur in an initial bedform corresponding to asymmetrical sandwaves characteristic of those found in the coastal and estuarine environment. It was found that suspended transport may frequently dominate over bed load transport in producing changes in the bedform structure. The predicted evolution of the bedform was consistent with observations made of sediment fluxes and sandwave migration in the Taw Estuary, England. (Author's abstract) W91-01675

#### BEARSPAW DEVELOPMENT: DESIGN AND CONSTRUCTION OF A SIDE-CHANNEL OVERFLOW SPILLWAY.

M. Pildysh, R. J. Slopek, J. O. H. Nunn, and R. A. Keys.  
Canadian Journal of Civil Engineering CJCBE8, Vol. 17, No. 3, p 423-430, June 1990. 7 fig, 1 ref.

Descriptors: \*Alberta, \*Dams, \*Flood control, \*Overflow channels, \*Spillways, \*Weirs, Channel improvement, Earth dams, Engineering, Erosion control, Flood-control storage, Heaving, Hydraulic engineering, Model studies, Reinforced concrete, Spillway gates.

An emergency spillway with a capacity of 1840 cu m/s has been built to increase the spillway capacity of the 30-year-old Bearspaw Development so that it can safely pass the probable maximum flood. A unique aspect of the free-overflow, side-channel emergency spillway is the weir. This consists of an earthfill dike with a cap and downstream facing of reinforced concrete. Comprehensive hydraulic model testing was undertaken to provide detailed design data and optimize the design of the emergency spillway. The overflow weir substructure is a zoned earthfill dike with a 2 mm thick polyethylene membrane at the top of the impervious core to prevent frost heave of the concrete lining. The reinforced concrete lining of the spillway is required for erosion protection and is designed to withstand the hydrodynamic drag and uplift forces caused by flowing water as well as piezometric uplift pressures due to seepage. An extensive underdrainage system was installed to reduce uplift pressures under the lining. An unlined return channel excavated through overburden and rock conducts spillway discharges back to the river. The Bearspaw Development side-channel spillway provides an example of design and construction of a major free-overflow spillway founded on a low-cost earthfill substructure. The overflow spillway, which was more economical and reliable than a conventional gated structure, was made technically and economically feasible through detailed engineering and extensive model testing. Conventional construction procedures were utilized to build an unconventional structure. (Agostine-PTT) W91-01721

#### RIVER DISCHARGE AND TIDAL CONTROLS ON SALT-WEDGE POSITION AND IMPLICATIONS FOR CHANNEL SHOALING: FRASER RIVER, BRITISH COLUMBIA.

Guelph Univ. (Ontario). Dept. of Geography.  
For primary bibliographic entry see Field 2L.  
W91-01722

### 8C. Hydraulic Machinery

#### POSSIBILITIES OF CONSTRUCTING HYDRO-ELECTRIC STATIONS: PUMPED STORAGE STATIONS IN ARMENIA.

V. B. Rostomyan, and G. A. Burnachyan.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p 704-706, June 1990. 1 fig, 2 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p 28-29, December 1989.

Descriptors: \*Armenia, \*Economic evaluation, \*Hydroelectric plants, \*Pumped storage, Electric power costs, Electric power demand, Electric power production, Hydroelectric power, Pumping head, Reservoir operation, USSR.

Pumped storage stations (PSSs), because of their flexibility in producing electric power at particular times, are necessary to meet the peak loads of modern power systems. The increasing electric power requirements of the Armenian republic, the increasing proportion of thermal electric power plants, the decrease in flexible capacity at existing hydroelectric stations (HESs) and the presence of favorable natural conditions indicated the need to introduce PSSs into the Armenian power system. This can be accomplished successfully and economically by reconstructing certain HESs of the Sevan-Razdan and Vorotan cascades. The Gyumush HES with a head of 285 m, discharge of 90 cu m/s, and installed capacity of 224 MW, the third step of the cascade, is the most powerful HES of the system and the most favorable for conversion to a HES-PSS operating regime. A discharge equal to 41 cu m/s will be used at the HES, which will provide a capacity of 102 MW. A capacity equal to 122 MW remains free. The volume of water required during the off-peak period of the load curve can be delivered by pumps from the lower pool of the existing HES during 7 h. The PSS will be located between the daily storage and the reservoir, with two reversible units: the turbine regime design discharge is 49 cu m/s with a 80 m head and a 38 MW capacity while the pump regime design discharge is 21 cu m/s with a head of 100 m and a capacity of 25 MW. Some 530,000 cubic m of water from the lower pool of the Gyumush HES will be delivered to the daily storage and further to the upper storage reservoir by a pump station constructed next to the HES. The pump station parameters are for a discharge of 21 cu m/s, a 295 m head and a 75 MW capacity. The daily energy for filling and discharging the PSS for a pure storage cycle is 480 MW. According to preliminary calculations, the unit investments in reconstructing the existing HES into a HES-PSS are 95 rubles/kW. The second and fifth steps of the cascade, the Atarbekyan and Kanaker HESs can also be transformed into HES-PSS by creating a daily storage at the end of the diversion canal of the second stage, deepening the daily storage of the fifth step, and constructing pump stations next to the powerhouses of the indicated stations. (Hoskin-PTT) W91-01439

#### PECULIARITIES OF THE FORMATION OF BOTTOM DEPOSITS IN A CLOSED-COOLING POND.

B. I. Novikov, and N. A. Chizhmarkova.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p 730-733, June 1990. 1 fig, 1 tab, 3 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p 49-51, December 1989.

Descriptors: \*Bottom sediments, \*Cooling ponds, \*Electric powerplants, \*Sediment distribution, \*Sedimentation, Artificial ponds, Bottom sampling, Hydrodynamics, Sediment analysis, Sediment transport, Suspended sediments.

The development of thermal and nuclear powerplants has resulted in an ever-increasing number of cooling ponds. The peculiarities of the process of bottom deposits deformation in a closed cooling pond were examined. The investigations were performed at two cooling ponds with level segments with depths of 5-6 m and closed trenches exceeding 10 m. The studies consisted in removing cores and individual samples from a network of stations uniformly disposed over the pool area. The basic characteristic of the formation of bottom sediments in closed cooling ponds is the predominant participation of indigenous materials in this process, which are products of the scouring of primary soils-submerged soils. It is precisely from these

products that the silts of the troughs and the sections protected from hydrodynamic action are formed. Consequently, any substance, including any harmful ones, will ultimately be concentrated on the bottom of the above-indicated sections of the body. This concentration is especially pronounced for substances associated with suspensions. (Hoskin-PTT) W91-01444

#### MECHANICAL EQUIPMENT OF THE TIKHOVSK HYDRO DEVELOPMENT ON THE KUBAN RIVER.

A. F. Levashova.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 10, p 569-572, April 1990. 2 fig, 6 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 12-14, October 1989.

Descriptors: \*Fish management, \*Fish passages, \*Hydraulic equipment, \*Hydroelectric plants, \*Locks, \*Soviet Union, Ecological effects, Fish guiding, Fish populations, Hydraulic gates, Irrigation water, Mechanical equipment.

The Tikhovsk (Soviet Union) hydro development on the Kuban River is located at the confluence of the Protoka River and the Kuban River. The hydro development is intended for irrigation purposes; the interests and requirements of the economy were taken into account when selecting the composition of the structures of the hydro development. Because great attention is being given to ecology and, in particular, to the reproduction and protection of fish, two fish locks are provided for at the Tikhovsk hydro development. In comparison with the navigation locks and overflow dam, the fish locks have the most complex and diverse mechanical equipment. Of the total mass of 2560 tons of mechanical equipment the fish locks accounts for 1130 tons. The upstream and downstream slotted gates form a working chamber in which the pools are isolated and the fish are examined and counted. Directly behind the upstream slotted gate is an ichthyological platform. The fish locks in addition to their main function—forceful transport of fish from the lower to the upper pool—can serve as a natural laboratory for developing ways of attracting various fish species. When designing the mechanical equipment of the fish locks, past experience in operating such structures was used. (Fish-PTT) W91-01540

#### MONITORING THE STATE OF THE DAM OF THE SAYANO-SHUSHENSKOE HYDROELECTRIC STATION.

For primary bibliographic entry see Field 8A.  
W91-01541

#### INITIAL PERIOD OF OPERATION OF THE CHANNEL DAM OF THE KUREIKA HYDRO-ELECTRIC STATION.

For primary bibliographic entry see Field 8A.  
W91-01542

#### EXPERIENCE IN OPERATING ECOLOGICALLY CLEAN TURBINES.

V. A. Lagutin, and G. P. Nekryachenko.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 10, p 584-586, April 1990. 1 tab. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 22-24, October 1989.

Descriptors: \*Hydraulic engineering, \*Hydraulic machinery, \*Hydraulic turbines, \*Hydroelectric plants, \*Soviet Union, \*Water pollution control, Ecological effects, Maintenance, Mechanical failure, Oil pollution.

The first turbine of the Cheboksary (Soviet Union) hydroelectric station that was put into operation has an oil-filled runner bushing; therefore, the possibility of oil entering the river in an amount specified by the standards of the manufacturer is possible. The other 17 turbines have water-filled bushings, and are ecologically clean. However, these turbines are mechanically unreliable; complete fail-

ure of the crossbeams on six turbines occurred in 1982-1985. Strengthening of the crossbeam, increasing the gaps, and replacing the bushings did not increase the reliability of the turbines. The turbine bearing is distinguished by an extremely low reliability, due to insufficient rigidity of the bearing housing, disturbance of the threading in the supports, difficult self-adjustment of the segment, transmission of tangential alternating forces through the bolt leading to partial or complete separation of the supports, and difficult repairs on the bearing owing to the confined space. At the hydrostation a number of operations to strengthen the bearings had to be carried out. An interdepartmental conference was forced to acknowledge that ecologically clean turbines do not provide the necessary reliability and do not correspond to the requirements of the specifications. Despite the unsuccessful introduction of ecologically clean adjustable-blade turbines into operation, the return to oil-filled runners should be decisively rejected, since the advantages of ecologically clean equipment are too obvious. It is necessary to develop a turbine that satisfies all operating conditions. (Fish-PTT)

W91-01543

#### DESIGN OF CRANES FOR OPERATING GATES.

I. K. Kaplan.

Hydrotechnical Construction HYCOAR, Vol. 23, No. 10, p 605-607, April 1990. 1 fig, 1 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 37-38, October 1989.

Descriptors: \*Hydraulic design, \*Hydraulic gates, \*Hydraulic machinery, \*Hydroelectric plants, Control systems, Mechanical failure, Safety, USSR.

Operation of hydraulic gates at hydroelectric stations may sometimes become difficult. When lifting a gate, it is possible for it to become wedged in the guideways of the groove, causing both overloading of the hoisting device and transmission of an increased pulling force from the hoisting device to the object being raised. It may also jam during lowering, whereupon the hoisting device continues to operate and sagging of the cable occurs, followed by a sudden drop of the gate with a jerk considerably exceeding the design load. A protection device for both the crane and the restrained load is needed. A device has been developed for controlling the hoisting mechanism for a gantry crane of the water intake and outlets of a hydroelectric station. Tests on a prototype at the hydrostation confirmed the performance of the device. The technical and economic indices are: (1) the possibility of changing the capacity of the hoisting mechanism allows reduction of the number (and weight) of mechanisms needed; (2) the possibility of crane overloading decreases due to the use of electrical and hydraulic apparatus; (3) operating safety on the crane increases, since the control apparatus is backed up in the device; and (4) if necessary, the device can be made as an independent drive of increased capacity with a small stroke for lifting the gate from the sill and with a reduced load lifting or lowering speed. (Fish-PTT)

W91-01548

#### WHAT RESULTS WHEN THE BUILDING CODES ARE NOT OBSERVED.

For primary bibliographic entry see Field 8B. W91-01550

#### OPTIMIZATION OF HYDROPOWER PLANT INTEGRATION IN WATER SUPPLY SYSTEM.

California Univ., Davis. Dept. of Land, Air and Water Resources. A. Afshar, F. B. Jemaa, and M. A. Marino. Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 116, No. 5, p 665-675, September/October 1990. 2 fig, 7 tab, 5 ref. Agricultural Research Service Cooperative Agreement 4116-H with the University of California, Davis.

Descriptors: \*Energy sources, \*Hydroelectric plants, \*Water delivery, \*Water resources manage-

ment, \*Water supply development, Available head, Dynamic programming, Hydraulic turbines, Hydroelectric power, Metropolitan water management, Model testing, Optimization, Pipes.

During the past few years many water districts have discovered that electricity generated by installing suitable hydroelectric power plants in water supply mains may now be cost-effective as an energy source. An optimization model has been developed for determining the optimal design capacities of a water delivery system integrating small hydropower plants. A discrete distance model of the transmission pipeline was solved by employing dynamic programming. The model determines the proper allocation of available pressure head to various potential hydropower sites along the supply main and determines the optimal pipe diameter. The practical value of the model was demonstrated in a supply system to serve four towns. The solution of the model gives the set of turbine capacities, pipe diameters, head allocation resulting in maximum net benefit for a given quantity of available water and demand, and the expected net benefits. (Author's abstract)

W91-01556

#### HYDROELECTRIC DAMS AND THE DECLINE OF CHINOOK SALMON IN THE COLUMBIA RIVER BASIN.

Marquette Univ., Milwaukee, WI. Dept. of Economics.

For primary bibliographic entry see Field 6G.

W91-01560

#### ACCOMMODATING FISH AND WILDLIFE INTERESTS UNDER THE FPA.

Gordon, Thomas, Honeywell, Malanca, Peterson and Daheim, Seattle, WA.

For primary bibliographic entry see Field 6E.

W91-01628

#### CALIFORNIA V. FERC: STATE REGULATION OF FEDERAL HYDROPOWER.

For primary bibliographic entry see Field 6E.

W91-01629

#### MECHANICAL EQUIPMENT OF THE TASHLYK PUMPED-STORAGE HYDROELECTRIC STATION AND ALEKSANDROVKA HYDRO DEVELOPMENT OF THE SOUTHERN UKRAINE POWER COMPLEX.

Y. V. Maksimenko, and V. S. Nesterenko. Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 617-620, 1990. 4 fig. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 6-7, November 1989.

Descriptors: \*Dams, \*Hydraulic gates, \*Hydraulic machinery, \*Hydroelectric plants, \*Nuclear powerplants, \*Soviet Union, \*Turbines, Gates, Hydraulic design, Hydraulic structures, Hydroelectric power, Slide gates, Ukraine.

The Southern Ukraine power complex includes a nuclear power station and three hydro developments: Tashlyk, Aleksandrova, and Konstantinovka. The Tashlyk hydro development is being created in a ravine located in the left-bank region of the Southern Bug River valley next to the upstream Konstantinovka hydro development. The Aleksandrova hydro development will be constructed 15 km downstream. The general layout of the facilities of the power complex was determined mainly by the location of a nuclear power station on the left bank of the Tashlyk reservoir. The Tashlyk pumped-storage hydroelectric station (PSS) provides combined operation of all power complex reservoirs for cooling the circulating waters of the Southern Ukraine nuclear power station. Six reversible units and four turbine units will be installed at the Tashlyk PSS. The water intake of the Tashlyk PSS is equipped with two absolutely identical emergency-guard slide gates 8.0 meters in width, 12.2 meters in height, and 24.0 m in head. The gate consists of four sections interconnected by hooks. The Aleksandrova hydro development will be used as a buffer in the Southern Ukraine power complex. It will consist of an

eight-bay overflow dam and a low-head powerhouse with two units. The overflow dam is equipped with fixed wheel gates 16.0 meters in width, 14.5 meters in height and with a head of 14.1 meters. These gates will serve as the service gates. The gates consist of two sections interconnected by hooks. Slide gates are used as the emergency-guard gates for purposes of economy of the mass of the embedded parts and gates. (Korn-PTT)

W91-01644

#### MECHANICAL EQUIPMENT OF THE VILYUI NO. 3 HYDROELECTRIC STATION.

V. V. Bychkov, and L. I. Perel'shtein. Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 620-627, 1990. 4 fig, 2 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 8-12, November 1989.

Descriptors: \*Dams, \*Hydraulic equipment, \*Hydraulic structures, \*Hydroelectric plants, \*Soviet Union, Bulkhead gates, Economic evaluation, Gates, Hydraulic design, Hydraulic gates, Hydroelectric power, Reservoirs, Slide gates, Turbines.

The Vilyui No. 3 hydroelectric station is the second step of the cascade of Vilyui hydroelectric stations and is located 140 km downstream from the Vilyui Nos. 1 and 2 hydroelectric station sites. The main elements of the Vilyui No. 3 hydrostation structures are the powerhouse combined with the bottom outlets, headwater and tailwater canals, earth-rock dam, and office-production building. The reservoir of the No. 3 hydrostation does not have a seasonal storage and the station will operate on the through-going flow from the Nos. 1 and 2 hydrostations. A thorough study of the project made it possible to unify elements of the set of mechanical equipment, which in turn led to an increase in its reliability, reduction of the time, labor intensity, and cost of manufacturing and installing the equipment. It also resulted in an improvement in the quality of manufacture and assembly as a result of the economically advantageous use of special assembly jigs. Eliminating the use of specially manufactured intake and draft tube bulkhead gates and emergency-guard gates of the bottom outlet saves 420,000 rubles and 450 tons of metal. In addition, a new design for the lining was used thereby reducing the amount of field welding and welding deformations in the structures. This eliminated labor-intensive manual operations on installing anchor rods on the assembled linings and thereby increased the factory readiness of the linings for assembly. In addition, the new lining design reduced the consumption of metal and the presence of cutoffs in the anchor ribs improved the concreting conditions. (Korn-PTT)

W91-01645

#### INVESTIGATION OF THE DIVERSION OUTLET OF THE KIRZAN HYDRO DEVELOPMENT.

For primary bibliographic entry see Field 8B.

W91-01646

#### EFFECT OF THE RIGA HYDROELECTRIC STATION ON THE CURRENT VELOCITY NEAR WHARVES OF THE RIGA COMMERCIAL SEAPORT.

For primary bibliographic entry see Field 8B.

W91-01647

### 8D. Soil Mechanics

#### ANALYTICAL METHOD OF CALCULATING SLOPE STABILITY.

I. A. Maslov. Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p 675-683, June 1990. 5 fig, 1 tab, 2 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p 9-14, December 1989.

Descriptors: \*Analytical, \*Dam construction, \*Engineering geology, \*Mathematical analysis, \*Slope stability, \*Soil mechanics, \*Mathematical equations, \*Mathematical studies, \*Shear stress, \*Soil engineering, \*Soil physics, \*Structural engineering.

## Field 8—ENGINEERING WORKS

### Group 8D—Soil Mechanics

Methods of calculating the stability of slopes of earth structures, based on an examination of sliding of a soil mass on a cylindrical surface and proceeding from the fact that the soil in the zone of this surface is in a limit state, are the most widespread in modern engineering practice. However, the conditions of equilibrium of the forces acting on the sliding mass are not fulfilled in most of these methods, reducing the accuracy of the solution obtained, sometimes quite substantially. An analytical method of calculating slope stability which satisfies the conditions of equilibrium and permits calculation without dividing the sliding mass into vertical elements is proposed. In addition to the assumption generally made in such problems concerning the presence on the failure surface of a limit state characterized by the Coulomb criterion, a likelihood law of distribution of normal stresses on the failure surface compatible with the conditions of equilibrium is assumed a priori. This makes the investigated problem definite and not too complex. Methods of calculating slope stability in which the equilibrium conditions are not fulfilled can be used only for preliminary calculations if there are no considerable horizontal loads. In this case, it is recommended to use Terzaghi's method, introducing a proposed correction factor to the frictional forces on the failure surface. In critical calculations it is necessary to use methods in which the equilibrium conditions are fulfilled. They give essentially the same results. (Hoskin-PTT) W91-01434

#### CORRESPONDENCE OF THE SCHEME AND METHOD OF CALCULATING THE STABILITY FACTOR.

V. I. Istomin.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p 689-693, June 1990. 3 fig, 5 tab, 6 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p 17-20, December 1989.

Descriptors: \*Mathematical analysis, \*Shear stress, \*Slope stability, \*Soil physics, Mathematical equations, Mathematical studies, Sliding wedge, Soil engineering, Structural engineering.

Three variants of a problem involving a sliding wedge form for an earth slope were calculated using the inclined forces of interaction (IFI) method, and the methods of Chugaev, Krey and Terzaghi. For the calculation of  $K_c$ , the stability factor of the experiment, a calculation accuracy of  $0.85 K_p < K_c < K_p$ , ( $K_p$  is the stability factor for the prototype) is guaranteed for  $\alpha < 15$  degrees ( $\alpha$  is angle between the lines of action of the resultants of the restraining and shearing forces) (the sliding wedge is separated from the slope by the sliding surface not having an ascending branch) for the Terzaghi method and its analogues, the Krey method and its analogues, and the IFI method. The same  $K_c$  accuracy is found for the Chugaev method for  $\alpha < 90$  degrees (the sliding wedge is separated from the slope by a sliding surface having an ascending branch, on the sliding surface the ratio of the angles of the internal friction should be  $\geq 1.1$ ). The ascending branch is the part of the sliding surface where the shear force is directed toward retaining the sliding wedge. (Hoskin-PTT) W91-01436

#### BEHAVIOR OF SOIL UNDER A BRIEF DYNAMIC LOAD.

O. A. Orlova.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 638-648, 1990. 5 fig, 1 tab, 6 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 20-26, November 1989.

Descriptors: \*Load distribution, \*Load testing, \*Shear stress, \*Soil dynamics, \*Soil mechanics, Distortional strain, Dynamic load, Elastic properties, Plasticity, Soil engineering, Soil physical properties, Soil strength, Strain measurement, Volumetric strain.

The behavior of an earth structure under a dynamic load is determined by its design and physical and mechanical characteristics of the materials composing it. These characteristics in turn depend on

the stress-strain state of the structure at the moment of the dynamic load start, as well as on the process of deformation of the soil under this load. An investigation was initiated in which both a cohesive and a noncohesive soil was placed under a combined stress state. The results of the investigation show that the damping coefficients both of cohesive and noncohesive soils do not depend on the soils state relative to the limit state almost up to loss of strength by the soil specimen. An increase of the initial lateral pressure and dry density of the noncohesive soil as well as a decrease of the moisture content of cohesive soil noticeably reduce the value of the damping coefficients. The shear moduli for small values of the initial lateral pressure under conditions of a combined stress state for cohesive soil depend on the level of the initial lateral pressure, while for the noncohesive soil it depends on the change in moisture content. Both volumetric strains and distortional strains under brief dynamic shear load and under conditions of a combined stress state are far less than the strains from an equal static load. The description of the soil deformation process as a result of a brief dynamic load shows the possibility of determining the nonlinear reaction of soil to this load by means of the linear acceleration method, if the system under consideration can be represented as a system with one degree of freedom. (Korn-PTT) W91-01649

#### SEEPAGE IN EARTH DAMS IN TWO- AND THREE-DIMENSIONAL FORMULATIONS OF THE PROBLEM.

L. N. Rasskazov, N. A. Aniskin, V. G. Zhelankin, V. V. Melakhanov, and V. F. Korchevskii.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 648-656, 1990. 8 fig, 8 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 26-32, November 1989.

Descriptors: \*Dams, \*Finite element method, \*Flow velocity, \*Hydraulic models, \*Hydraulic structures, \*Seepage, \*Soil mechanics, \*Soviet Union, Fluid mechanics, Hydraulic properties, Permeability coefficient, Rapid excavation, Seepage gradient, Unconfined flow.

At present, problems of unconfined seepage flows are solved by hydraulic methods, since fluid mechanical solutions are complex and applicable to a limited class of problems. Three-dimensional regions do not have direct fluid mechanical solutions. The problem is complicated when dams being constructed by a directed blast are examined, since inhomogeneity and anisotropy of the soil and nonlinearity of the relation between the flow velocity and seepage gradient occurs. A method and program were developed for calculating nonlinear seepage in blast-formed dams, which makes it possible to obtain the solution of a three-dimensional problem for an inhomogeneous, anisotropic region of a complex geometric form under arbitrary boundary conditions. In a dam composed of material having a nonlinear law of seepage, the position of the surface of depression is higher than for the case when a linear (laminar) seepage law is used. Consideration of three-dimensionality when solving the problem of nonlinear seepage in a blast-formed dam with a height of 70 m showed that the seepage discharge was somewhat greater and the position of the surface of depression was higher than for the case of the two-dimensional problem. This eliminates the need for solving three-dimensional seepage problems for this structure class. (Korn-PTT) W91-01650

#### CAUSES AND CHARACTER OF MOVEMENTS OF THE LOAMY SAND MORaine IN THE FOUNDATION OF THE PLYAVINYAS HYDROELECTRIC STATION POWERHOUSE.

M. P. Leonov.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 657-660, 1990. 4 tab, 6 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 33-35, November 1989.

Descriptors: \*Foundation failure, \*Foundation rocks, \*Hydroelectric plants, \*Loam, \*Moraines,

\*Pipes, \*Sand, \*Soil erosion, \*Soil mechanics, \*Soviet Union, Erosion, Piping erosion, Soil dynamics, Soil physical properties, Soil properties, Soil stability.

The Plyavinyas hydroelectric station powerhouse, in operation since 1965, has a foundation composed of moraine loams and loamy sands characteristic of the ancient valley of the Daugava River. In the lower part of the strata weakly cemented sands and sandstones with infrequent thin interlayers of clay belonging to the Amata and Gauya suites occur. The zone of the Amata-Gauya rocks in the valley walls and floor in the immediate vicinity of the boundaries of the erosional incision, which after filling the valley with glacial deposits was in close contact with the moraine, was eroded by piping. Long-term operation of the drainage systems during construction and operation of the hydro development was accompanied by intensified removal of sand, which led to the revival of the process of piping erosion of the rocks under the base of the moraine. Loamy sand moraine movements in the foundation of the right-bank abutment of the powerhouse were most probably due to the caving in of large piping cavities in the underlying rocks. Taking into account the available data on the geological structure of the foundation and physical and geological processes occurring, the possibility of new loamy sand moraine movements in its right-bank is a possibility. Under the established conditions it is necessary to take urgent measures to limit the continuing piping erosion of the Amata-Gauya strata by removing sand through the vertical drain wells in the area near the station. The most radical solution would be maximum dispersal of water withdrawal by transferring the center of the discharge zone a greater distance from the powerhouse and complete cessation of the operation of nearby high-output wells. (Korn-PTT) W91-01651

### 8E. Rock Mechanics and Geology

#### DESIGN OF ROCK SLOPES IN SOVIET HYDROPOWER CONSTRUCTION PRACTICE.

For primary bibliographic entry see Field 8A. W91-01433

#### SOLUTION-COLLAPSE DEPRESSIONS AND SUSPENSATES IN THE LIMNOCENIC LAKE OF BANYOLES (NE SPAIN).

Barcelona Univ. (Spain).  
For primary bibliographic entry see Field 2J. W91-01876

### 8F. Concrete

#### MONITORING HIGH CONCRETE DAMS DURING THEIR CONSTRUCTION AND SERVICE.

E. K. Aleksandrovskaya.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p 708-714, June 1990. 2 fig, 10 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p 33-37, December 1989.

Descriptors: \*Concrete dams, \*Dam construction, \*Dam inspection, \*Dam stability, Construction joints, Dam design, Dam failure, Data analysis, Mathematical analysis, Mathematical models, Model studies, Monitoring, Seepage, Soviet Union.

A comparison was made between observed and computed basic control parameter values in the construction and construction-service periods to evaluate the condition of the high arch-gravity dam at the Sayano-Shushenskoe hydroelectric plant. Measured and computed values were compared for four periods during the rise in the level of the headrace, which occurred in 1983, 1984, 1986 and 1987. An overall assessment of the dam's condition was made on the basis of the comparison between measured parameters and their computed values. The incomplete dam's profile, determined

from concrete elevations and computed for increments of hydrostatic pressure and the weight of concrete masonry, was adopted on the basis of conditions at the outset of the rise in headrace level for each of these periods during filling of the reservoir; temperature effects were disregarded. The comparison between the measured and computed values for three roadway sections indicated that the radial displacement from the computation for the first three ascents of the headrace level exceeded the measured values. In 1987, however, the computed displacements exceeded the measured by 440 m, while the measured values exceeded the computed in the lower portion of the dam. The arch stresses in the concrete at the maximum headrace level were identical with the computed values; several of them however, exceeded the computed values, especially in the key section of the dam. Continuous comparison between computed and measured arch stresses indicated that until a certain moment in 1987, the computed values exceeded the measured. Subsequently, the measured stresses exceeded the computed as the headrace level reached maximum (1986) elevations. During the second ascent of the headrace level from 500 to 532 m in 1988, the computed stresses again exceeded the measured. This suggested a more elastic stage of structure performance in 1988 as compared with the previous year. The noncorrespondences between the mathematical model and the prototype were due to the disregard of temperature effects on the dam and the opening of the contact joint, which was not precisely defined in the computations. During continuous service, the monitoring of high concrete dams should be performed by automated, computerized systems capable of determining discrepancies between computed and measured data. (Hoskin-PTT)  
W91-01440

#### MECHANISM OF THE OPENING OF THE CONCRETE-ROCK JOINT IN THE SAYANO-SHUSHENSKOE DAM.

V. A. Ulyashinski, S. N. Starshinov, and V. V. Tetelmin.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 12, p 714-719, June 1990. 3 fig, 3 tab, 10 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 12, p 37-41, December 1989.

Descriptors: \*Concrete dams, \*Construction joints, \*Dam failure, \*Dam stability, \*Soviet Union, Bed load, Dam design, Dam inspection, Data analysis, Hydrologic properties, Hydrostatic pressure, Mathematical analysis, Mathematical models, Model studies.

The opening of the contact joint between the concrete and rock in the zone of the upstream face of the bed sections of the Sayano-Shushenskoe dam, first noted during the filling of the reservoir, has been continuously increasing. Monolithizing of the dam during its construction was repeated annually after seasonal drawdown of the reservoir in the winter-spring period. This has caused 'bridging' of the dam on the shoreline slopes and the appearance of an additional retaining moment, which prevented the tilting and deflection of the dam's channel sections. Two alternate schemes of computing the stress-strain state of the canyon were performed by the finite-element method, one assuming the dam is a monolithic body and one assuming it nonmonolithic. In the case of the monolithic dam, some of the load due to its own weight, including the channel sections, is taken up by the shoreline slopes. This causes a reduction in normal stresses at the concrete-rock contact in the region of the upstream face, especially in the bed sections adjacent to the shoreline slopes. Since the hydrostatic pressure on the bottom of the canyon causes corresponding bed deformations, conditions were created that contributed to separation of the bed from the dam and to opening of the contact joint. On the whole, seasonal warming apparently exerted a positive influence on the performance of the contact joint in the region of the upstream face. Seepage processes in the bed also exerted a major influence on the formation of the stress-strain state at the concrete-rock contact. Thus, a zone with tensile stresses, which does not completely disappear during seasonal drawdowns of the reservoir, exists at the concrete-rock contact in the region of

the upstream face of the Sayano-Shushenskoe Dam. The condition of the dam is currently considered satisfactory, although a rise in the headrace level to the normal operating level, and also subsequent seasonal fillings and drawdowns of the reservoir may cause further opening of the joint and its associated deterioration of the structure's condition. (Hoskin-PTT)  
W91-01441

#### CONCERNING THE PROBLEM OF ASSIGNING THE COMPOSITIONS OF STEEL FIBER-REINFORCED CONCRETES.

L. M. Deryugin.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 10, p 608-611, April 1990. 2 fig, 3 tab. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 38-41, October 1989.

Descriptors: \*Concrete dams, \*Concrete technology, \*Dam construction, \*Dam design, \*Hydraulic design, \*Hydroelectric plants, Concrete mixes, Materials engineering, Reinforced concrete, Sand, Soviet Union, Spillways.

Passage of the flood discharges of the Enisei River in the Soviet Union through the temporary spillway openings of the second level of the Sayano-Shushenskoe dam in 1980-1982 led to serious erosion of the concrete surfaces. Construction of the permanent spillways was approached from two fundamentally different aspects: the provision of a hydraulic regime safest from cavitation erosion; and the search for a material considerably more resistant to the effect of cavitation in order to create surfaces able to withstand high-velocity flow (55 m/s) on the permanent spillways. Steel fiber-reinforced concrete, which was successfully used for treating damages of the concrete at a hydro development in Pakistan, was examined as one of the possible variants. It was found that a considerable increase of the content of sand in comparison with ordinary concrete mixes is required for preparing workable fiber-reinforced concrete mixes. The optimal content of sand should be selected experimentally in relation to the particular properties of the aggregates and length, cross section, and content of fiber. Fiber can be regarded as a coarse aggregate of acicular form with a developed surface, for binding of which an increased quantity of the mortar component is necessary. When using fiber in the form of wire lengths without additional anchorage on the ends, its length can be taken equal to 60-65 diameters without a substantial decrease of the tensile strength of the fiber-reinforced concrete. A reduction in length of the fiber to these limits considerably decreases clumping of the fiber during mixing. (Fish-PTT)  
W91-01549

#### GEODETIC PROBLEMS IN THE CONSTRUCTION OF HIGH CONCRETE DAMS.

For primary bibliographic entry see Field 8A.  
W91-01652

#### INVESTIGATION OF CONCRETE IN ABSORBING FORMWORK.

R. N. Shmantar, T. A. Kuznetsova, and L. A. Petrova.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 11, p 665-668, 1990. 2 tab, 4 ref. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 11, p 39-41, November 1989.

Descriptors: \*Cements, \*Concrete technology, \*Concrete testing, \*Concretes, \*Formwork, Ensonite, Hydraulic structures, Soviet Union, Water to cement ratio.

The face surface of formwork should have an absorbing layer to promote surface hardening of the concrete. A series of investigations were carried out to determine the effectiveness of absorbing formwork on concrete using water to cement ratios (W/C) of 0.365. The results of the investigation indicated that absorbing formwork has a substantial effect on concrete quality for concretes with W/C greater than or equal to 0.365. The concrete surface quality depends on the quality of

the absorbing formwork materials used. The possible amount of water removed from the concrete by means of the absorbing (vacuum) formwork was 2.4-3.57 kg/sq m. Before the start of hardening of the concrete, its water content decreases by 20-30% at a depth to 15 cm from the absorbing formwork. During hardening of the concrete, its water content equalizes over the entire length of the specimen (thickness of the block), and under these conditions the W/C ratio of the concrete near the formwork is not more than 1% below the initial ratio. According to the results of concrete testing for cavitation resistance, the best indices were noted for formwork containing ensonite. In this case, the cavitation resistance of the concrete was increased up to 1.4 times. This circumstance permits the use of formwork absorbing material such as fine-porous paperboard of the ensonite type (with pore sizes 20-100 nm), which freely passes water molecules but retains cement particles. (Korn-PTT)  
W91-01653

#### DAM RENOVATION: FROM INVESTIGATION TO REPAIR.

Bridgeport Hydraulic Co., CT.  
E. M. Bernard.  
Journal of the American Water Works Association JAWWA5, Vol. 82, No. 8, p 28-34, August 1990. 2 fig.

Descriptors: \*Concrete technology, \*Dams, \*Maintenance, \*Rehabilitation, Concrete dams, Connecticut, Gravity dams, Leakage.

Bridgeport Hydraulic Company (BHC) in southwestern Connecticut has undertaken a comprehensive renovation program to identify and schedule necessary repairs to each of its 21 concrete gravity dams, all of which were built in the early part of this century. Renovation efforts at two BHC dams (Easton Dam and Means Brook Dam) from initial investigatory work to final design and construction are described. Although both projects involved concrete gravity dams that were constructed during the same period and exhibited similar freeze-thaw damage, distinctly different repair approaches were formulated. In the case of Easton Dam, repairs made to control leakage through the dam were undertaken because of the amount of leakage and repairs of the concrete surfaces were split into separate renovation projects for the crest and the downstream surface because of the size of the dam. Cast-in-place concrete was employed for the crest, whereas the method to be used for the downstream surface remains undecided. At Means Brook Dam, leakage control repairs were deemed unnecessary; repairs of the concrete surfaces will be undertaken with cast-in-place concrete for the crest and precast panels for the downstream surface. Factors that affect the renovation approach of any dam are reviewed. (Agostine-PTT)  
W91-01748

## 8G. Materials

#### MONITORING HIGH CONCRETE DAMS DURING THEIR CONSTRUCTION AND SERVICE.

For primary bibliographic entry see Field 8F.  
W91-01440

#### DIMENSIONLESS STRAIGHT-TYPE LINES FOR AQUIFER TESTS.

King Abdulaziz Univ., Jeddah (Saudi Arabia).  
Dept. of Hydrogeology.  
For primary bibliographic entry see Field 2F.  
W91-01497

#### EXPERIENCE IN USING DIGITAL VOLT-METERS IN THE SYSTEM MEASURING THE POOL LEVELS AND HEAD AT HYDROELECTRIC STATIONS.

V. E. Kornev, and M. B. Dolgii.  
Hydrotechnical Construction HYCOAR, Vol. 23, No. 10, p 598-600, April 1990. 2 fig. Translated from *Gidrotekhnicheskoe Stroitel'stvo*, No. 10, p 32-34, October 1989.

## Field 8—ENGINEERING WORKS

### Group 8G—Materials

Descriptors: \*Hydraulic equipment, \*Hydroelectric plants, \*Measuring instruments, \*Sensors, \*Watershed management, Pressure head, Soviet Union, Water depth.

General industrial sensors are presently finding wide use at hydroelectric stations for measuring the pool levels and head. Milliammeters are used as the direct reading instruments. These milliammeters and indicating instruments have a low resolution and do not always meet the accuracy requirements imposed on readings. It is suggested that digital voltmeters be used instead as indicating instruments, however it is necessary to install a matching device at the input of the digital voltmeters for interfacing with the output signal of the sensor. The reference voltage is fed to the voltage divider. A voltage proportional to the minimum or maximum value of the elevation of the pool level is set by potentiometers. The algebraic sum of the voltages is fed to the input of the digital voltmeter for displaying the value of the present parameter. Measuring systems which use digital voltmeters have been operating for several years at a number of hydrostations in the Soviet Union, their operation has been reliable. The introduction of digital voltmeters as indicating instruments in circuits measuring the pool levels and head make it possible to have convenient information providing accurate readings of the parameters of interest. (Fish-PTT)  
W91-01546

### 8H. Rapid Excavation

**EFFECTIVE DESIGN OF FACINGS OF BLAST-FORMED DAMS.**  
For primary bibliographic entry see Field 8A.  
W91-01547

### 8I. Fisheries Engineering

**EFFECT OF BODY SIZE ON THE UPTAKE AND BIOCONCENTRATION OF DI-2-ETHYL-HEXYL PHTHALATE IN RAINBOW TROUT.**  
Washington State Univ., Pullman. Coll. of Pharmacy.  
For primary bibliographic entry see Field 5B.  
W91-01257

**EVALUATION OF DESIGNS OF PERIODIC COUNT SURVEYS FOR THE ESTIMATION OF ESCAPEMENT AT A FISHWAY.**  
Department of Fisheries and Oceans, Halifax (Nova Scotia). Biological Sciences Branch.  
For primary bibliographic entry see Field 7A.  
W91-01384

**TEMPERATURE SELECTION BY STRIPED BASS IN A GULF OF MEXICO COASTAL RIVER SYSTEM.**  
Georgia Cooperative Wildlife Research Unit, Athens.  
M. J. Van Den Avyle, and J. W. Evans.  
North American Journal of Fisheries Management NAJMDP, Vol. 10, No. 1, p 58-66, Winter 1990. 3 fig, 3 tab, 21 ref. U.S. Fish and Wildlife Service Project AFS-13.

Descriptors: \*Fish behavior, \*Gulf of Mexico, \*Striped bass, \*Temperature effects, Apalachicola River, Fish populations, Monitoring, Seasonal variation, Telemetry.

Behavior of adult striped bass *Morone saxatilis* in the Flint River-Lake Seminole portion of the Apalachicola River system was evaluated to determine if temperature preferences differed from those of striped bass from Atlantic coast stocks. Radiotelemetry was used to monitor fish distribution and temperature selection from March 1984 to November 1985. Seasonal distribution patterns and influences of water temperature on striped bass behavior were similar to those reported elsewhere for Atlantic striped bass. The fish ranged widely and occurred throughout the 166-km-long study area during fall, winter, and spring. During summer, however, they inhabited spring-fed areas almost

exclusively. The fish moved into these sites during May, when surrounding waters averaged 24.3 C, and remained there through late October or early November, when ambient water temperatures declined to an average of 20.1 C. Temperatures selected by the fish averaged 21.6 C during both summers. When the data were separated into subsets of native Gulf and introduced Atlantic striped bass by the use of previously reported meristic characteristics, there were no differences between groups for average temperatures selected during summer or for temperatures at which the fish moved into or out of springs. The results indicated that preferred temperatures of striped bass in the Apalachicola River are not higher than those of other stocks. (Author's abstract)  
W91-01385

**EFFECT OF HARDNESS AND SALINITY ON SURVIVAL OF STRIPED BASS LARVAE.**  
Maryland Univ. at Baltimore. Dept. of Pathology.  
A. S. Kane, R. O. Bennett, and E. B. May.  
North American Journal of Fisheries Management NAJMDP, Vol. 10, No. 1, p 67-71, Winter 1990. 2 fig, 1 tab, 22 ref.

Descriptors: \*Bioassay, \*Fish hatcheries, \*Fish larvae, \*Hardness, \*Salinity, \*Striped bass, \*Survival, Calcium carbonate, Chemical properties, Fish physiology, Sodium chloride.

Larval striped bass *Morone saxatilis* were exposed to three hardness concentrations (40, 100, and 160 mg/L as CaCO<sub>3</sub> equivalents) and two NaCl salinities (2.0 and 3.0 ppt) treatments for 10 d in a modified flow-through system. Salinity had a greater effect on larval survival than did hardness over the ranges tested. Elevated NaCl salinity appeared to be detrimental; larvae exposed to 3.0 ppt NaCl had significantly higher mortality than did those exposed to 2.0 ppt NaCl. At 2.0 ppt salinity, hardness does not appear to play an important role in larval survival (probability of survival > 0.70). At 3.0 ppt salinity, mortality was greatest at hardness levels of 40 and 100 mg/L (probability of survival = 0.06 and 0.01, respectively), whereas at 160 mg/L, mortality was reduced (probability of survival = 0.39). The reason for this response is not clear, although there may be an optimal ratio of different ions contributing to total salinity. By comparison, other studies in which diluted seawater was used indicated that salinities of 0.5-10.0 ppt enhance the survival of striped bass larvae. (Author's abstract)  
W91-01386

**RELATIONS BETWEEN BROOK TROUT STANDING STOCKS AND HABITAT FEATURES IN BEAVER PONDS IN SOUTHEASTERN WYOMING.**  
Wyoming Cooperative Fishery and Wildlife Research Unit, Laramie.  
P. L. Winkle, W. A. Hubert, and F. J. Rahel.  
North American Journal of Fisheries Management NAJMDP, Vol. 10, No. 1, p 72-79, Winter 1990. 1 fig, 7 tab, 25 ref.

Descriptors: \*Aquatic habitats, \*Beaver ponds, \*Brook trout, \*Fish populations, \*Limnology, \*Wyoming, Dissolved solids, Elevation, Regression analysis, Standing stock, Water depth.

Relations between abundance of brook trout *Salvelinus fontinalis* and habitat features of ponds made by beavers *Castor canadensis* were determined in 1986 and 1987 from observations of 25 southeastern Wyoming ponds. Standing stocks of fish longer than 100 mm in total length ranged from 5 to 313 kg/hectare, and densities ranged from 27 to 9,812 fish/hectare among 0.02-0.51-hectare ponds at elevations from 2,341 to 2,969 m above mean sea level. Of 25 habitat features, 6 were correlated with brook trout standing stock or density: surface area, mean water depth, water volume, discharge into pond, elevation, and morphoedaphic index (total dissolved solids (mg/L)/mean depth (cm)). The presence of young-of-year brook trout in beaver ponds was also related to both standing stock and density of brook trout longer than 100 mm in total length. Two multiple-regression models based on a rating of natural recruitment

potential and pond surface area accounted for significant variation in brook trout standing stocks (adjusted R sq = 0.42) and densities (adjusted R sq = 0.50). The models provide a potential tool for assessment of beaver ponds as habitat for brook trout in southeastern Wyoming. (Author's abstract)  
W91-01387

**POTENTIAL APPLICATION OF MODELS IN FORECASTING THE EFFECTS OF CLIMATE CHANGES ON FISHERIES.**  
Oak Ridge National Lab., TN. Environmental Sciences Div.  
For primary bibliographic entry see Field 2B.  
W91-01392

**TEMPERATURE-OXYGEN HABITAT FOR FRESHWATER AND COASTAL STRIPED BASS IN A CHANGING CLIMATE.**  
Oak Ridge National Lab., TN. Environmental Sciences Div.  
For primary bibliographic entry see Field 2B.  
W91-01393

**POTENTIAL LOSS OF THERMAL HABITAT FOR BROOK TROUT, DUE TO CLIMATIC WARMING, IN TWO SOUTHERN ONTARIO STREAMS.**  
Toronto Univ. (Ontario). Dept. of Zoology.  
J. D. Meisner.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 282-291, March 1990. 3 fig, 3 tab, 28 ref. NSF and Engineering Research Council of Canada Grant OGP0003918.

Descriptors: \*Aquatic habitats, \*Climatic changes, \*Climatology, \*Fish populations, \*Global warming, \*Ontario, \*Stream fisheries, \*Thermal effects, \*Trout, Air temperature, Brook trout, Groundwater, Model studies, Seasonal variation.

A hydrometeorological model of stream temperature was calibrated to two southern Ontario streams the Rouge and Humber Rivers, in the summer to estimate potential reductions, due to climatic warming, of thermal habitat for brook trout *Salvelinus fontinalis*. Summer habitat for brook trout in both streams, determined from electrofishing surveys during 1987 and 1988, was delimited downstream by a thermal barrier of about 24 C. Tagging data for one stream suggested that brook trout moved upstream to summer habitat as water temperatures in downstream areas increased during spring and summer. To estimate upstream movement of the thermal habitat barriers and concomitant reductions in summer habitat for brook trout due to climatic warming, the calibrated stream models were forced with the changes in mean July and August air temperatures (increase, 4.1 C) projected for the region by the climate warming scenario of the Goddard Institute for Space Studies. The temperature of groundwater discharging to the streams by the projected change in mean annual air temperature (increase, 4.8 C) was also adjusted. Elevated air and groundwater temperatures increased maximum summer stream temperatures and moved the thermal habitat barriers upstream, which reduced summer thermal habitat for brook trout in the two streams by 42 and 30%. However, because groundwater temperatures will always be lower than summer air temperatures, the cooling function of groundwater in streams will be maintained. The fate of a stream population of brook trout in a 'warmer' climate will be determined by the volume of groundwater discharging to the stream and the space available to which the fish can retreat in summer. (Author's abstract)  
W91-01397

**SIZE-DEPENDENT WINTER MORTALITY OF YOUNG-OF-THE-YEAR WHITE PERCH: CLIMATE WARMING AND INVASION OF THE LAURENTIAN GREAT LAKES.**  
York Univ., Toronto (Ontario). Dept. of Biology.  
T. B. Johnson, and D. O. Evans.  
Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 301-313, March 1990.

## Fisheries Engineering—Group 81

7 fig, 4 tab, 58 ref.

Descriptors: \*Climatic changes, \*Climatology, \*Fish populations, \*Global warming, \*Great Lakes, \*Introduced species, \*Limnology, \*Perch, \*Temperature effects, Age classes, Body size, Distribution, Foods, Mortality, Seasonal variation, White perch.

White perch *Morone americana* invaded Lake Ontario about 1946 and are now found in Lakes Erie, St. Clair, and Huron, and in Green Bay, Lake Michigan. The indigenous marine distribution of white perch along the Atlantic coast of North America and an analysis of climatological data suggest that the northern Gulf of St. Lawrence in the vicinity of the Gaspé Peninsula is too cold to permit white perch to establish local populations or to invade the Great Lakes via the St. Lawrence River. High mortalities of white perch have occurred in Lake Ontario during very cold winters, further suggesting that distribution of white perch is limited by low tolerance of cold temperature. Warmer-than-average summer and winter temperatures during the late 1940s coincided with the invasion of white perch into the Great Lakes via transportation canals in the state of New York. Tolerance of young-of-the-year white perch for low temperature was tested in the laboratory in overwinter experiments at constant temperatures of 2.5 and 4.0 °C. Winter mortality was strongly influenced by body size, winter duration, temperature, and food availability. At 4.0 °C, mortality was high for the smallest fish when food was withheld, but no mortality occurred under ad libitum feeding. The observed mortality for starved fish held at 4.0 °C for 180 d was 40.6%. At 2.5 °C, observed mortality was much higher than at 4.0 °C and body size and winter duration continued to have strong effects. The results suggest that continued climate warming due to the 'greenhouse effect' would lead to improved recruitment and expansion of the range of white perch in the Great Lakes, because growth and size of young-of-the-year would be enhanced by longer growing seasons and winters would be shorter and less severe. (Author's abstract) W91-01399

#### CLIMATE CHANGE AND FISH COMMUNITIES: A CONCEPTUAL FRAMEWORK.

Alberta Univ., Edmonton. Dept. of Zoology. W. M. Tonn. Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 337-352, March 1990. 2 fig, 4 tab, 98 ref, append.

Descriptors: \*Climatic changes, \*Ecosystems, \*Fish populations, \*Fisheries management, \*Global warming, \*Temperature effects, Community structure, Distribution, Habitats, Lakes, Species composition.

Many autecological effects of temperature on fish are known, and fishery biologists have begun to incorporate this knowledge into population-level relations that can be used to assess possible effects of climatic warming on fishes and their habitats. However, the problem of extrapolating these or other relations to multispecies assemblages is not straightforward, given the complexity of community-level phenomena. A conceptual framework that views fish assemblages as products of a series of filters, operating at different spatial and temporal scales, through which an assemblage's component species must pass is presented. This framework can facilitate an understanding of the processes that organize fish assemblages and suggest ways in which the complex problem can be divided into manageable pieces. This framework is applied to an examination of small-lake fish assemblages in three regions on two continents. The procedure reveals local and regional relations of richness and composition and highlights the importance of isolation, extinction, and colonization, as well as temperature, that must be considered in climate change assessments. This community-level framework can organize accumulated knowledge of fish assemblages, identify causal processes behind community-level patterns, and focus research needed for the management of fish assemblages in the face of major anticipated changes in climate. (Author's abstract)

W91-01401

#### IMPLICATIONS OF CLIMATE CHANGE FOR FISHERIES MANAGEMENT POLICY.

Department of Fisheries and Oceans, Nanaimo (British Columbia). Pacific Biological Station. M. C. Healey. Transactions of the American Fisheries Society TAFSAI, Vol. 119, No. 2, p 366-373, March 1990. 3 fig, 37 ref.

Descriptors: \*Climatic changes, \*Environmental policy, \*Fisheries management, \*Global warming, \*Policy making, Adaptation, Equilibrium models, Prediction, Remedial policies.

It is now generally agreed that world climate will warm significantly over the next half century, but the effects of that warming on fishery resources are uncertain. Unpredictable changes in biological systems that result from perturbations such as climatic warming can be classified into four types: (1) changes that are consistent with current equilibrium models (predictions); (2) high-frequency, short-lived changes that cannot be predicted by current models (noise); (3) low-frequency, short-lived changes that cannot be predicted by current models (anomalies); and (4) low-frequency, long-lived changes that cannot be predicted by current models (catastrophes). Climatic change is a gradual process and the responses of biological systems are generally expected to be of the first type. However, increases in both the frequency and amplitude of the other types of response cannot be ruled out. The typical, incremental, remedial policy adjustment of governments and agencies is unsuited to uncertain changes in fishery resource dynamics of types 2-4, particularly those of type 4. An emphasis on mitigating the effects of climatic change is also likely to be unsuccessful because it focuses on the status quo and ignores opportunities that may be inherent in the changes taking place. Bolder policies that involve adaptation to new climate conditions and experimental probing of system behavior are more likely successful. (Author's abstract) W91-01402

#### MECHANICAL EQUIPMENT OF THE TIKHOVSKY HYDRO DEVELOPMENT ON THE KUBAN RIVER.

For primary bibliographic entry see Field 8C. W91-01540

#### ACCOMMODATING FISH AND WILDLIFE INTERESTS UNDER THE FPA.

Gordon, Thomas, Honeywell, Malanca, Peterson and Daheim, Seattle, WA. For primary bibliographic entry see Field 6E. W91-01628

#### INTEGRATION OF LONG-TERM FISH KILL DATA WITH AMBIENT WATER QUALITY MONITORING DATA AND APPLICATION TO WATER QUALITY MANAGEMENT.

Post, Buckley, Schuh and Jernigan, Inc., Columbia, SC. For primary bibliographic entry see Field 5C. W91-01635

#### REDD SITE SELECTION BY BROWN TROUT IN DOUGLAS CREEK, WYOMING.

Wyoming Cooperative Fishery and Wildlife Research Unit, Laramie. R. T. Grosz, W. A. Hubert, and T. A. Wesche. Journal of Freshwater Ecology JFREDW, Vol. 5, No. 3, p 365-371, June 1990. 3 fig, 2 tab, 13 ref.

Descriptors: \*Douglas Creek, \*Fish behavior, \*Mountain streams, \*Trout, \*Wyoming, Aquatic habitats, Fish populations, Habitats, Spawning, Water depth.

The surface features of brown trout redds constructed by a resident population in Douglas Creek (a moderate-sized stream in the central Rocky Mountains) were studied and compared to measurements reported in the literature. The specific objectives were to describe spawning habitat used

(water depth, water velocity, and substrate type) by brown trout and to assess selection for spawning habitat features. Average redd length was 147 cm, water depth 16 cm, and water velocity 34 cm/s, but variation was substantial. Brown trout selected water depths of 12-18 cm and velocities of 24-37 cm/s and avoided depths less than 6 cm and velocities less than 12 cm/s. Water depths and velocities measures over redds in 1987 and 1988 were similar to those measured in 1975 despite a 50-100% increase in the minimum flow during the 1987 and 1988 spawning periods. (Agostine-PTT) W91-01745

#### ABUNDANCE OF SPAWNING PACIFIC SALMON IN TWO LAKE SUPERIOR STREAMS, 1981-1987.

Department of Fisheries and Oceans, Sault Ste. Marie (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences. J. R. Kelso, and D. B. Noltie. Journal of Great Lakes Research JGLRDE, Vol. 16, No. 2, p 209-215, 1990. 4 tab, 28 ref.

Descriptors: \*Dam effects, \*Fish migration, \*Fish passages, \*Lake Superior, \*Salmon, Fish populations, Spawning.

Mark and recapture procedures were used to examine the abundance of Pacific salmon entering two Lake Superior tributaries to spawn between 1981 and 1987. In 1987, abundance of pink salmon in the Carp and Pancake rivers declined to 50 and 25%, respectively, of that observed in 1981. In contrast, abundance estimates and catch records indicated that coho and chinook salmon had increased since 1981. The construction of a lowhead barrier dam on the Carp River in 1983/84 allowed passage of coho and chinook but precluded passage by pink salmon. Construction of the barrier dam did not appear to be the major cause for changes in abundances of pink salmon. Most mature pink salmon (> 50% of total abundance) entered the spawning streams during a two-week period following either onshore wind or a heavy rainfall. It is premature to suggest a lake-wide decline in pink salmon abundance. (Author's abstract) W91-01791

#### ESTIMATION OF RECRUITMENT FORGONE RESULTING FROM LARVAL FISH ENTRAINMENT.

Michigan Univ., Ann Arbor. School of Natural Resources. For primary bibliographic entry see Field 6G. W91-01794

#### COMPARISON OF THE DIETS OF GULF KILLIFISH, *FUNDULUS GRANDIS* BAIRD AND GIRARD, ENTERING AND LEAVING A MISSISSIPPI BRACKISH MARSH.

Louisiana Universities Marine Consortium, Chauvin. For primary bibliographic entry see Field 2L. W91-01909

#### VARIATIONS IN STRUCTURE OF ESTUARINE FISH COMMUNITIES IN RELATION TO ABUNDANCE OF SUBMERSED VASCULAR PLANTS.

Maryland Dept. of Natural Resources, Annapolis. For primary bibliographic entry see Field 2L. W91-01926

#### SPATIAL AND TEMPORAL DISPERSION PATTERNS OF GOLDEN PERCH, *MACQUARIA AMBIGUA*, LARVAE IN AN ARTIFICIAL FLOODPLAIN ENVIRONMENT.

New South Wales Dept. of Agriculture, Narrandera (Australia). Inland Fisheries Station. For primary bibliographic entry see Field 2H. W91-01957

#### EFFECTS OF LOW PH ON THE CHORION OF RAINBOW TROUT, *ONCORHYNCHUS*

## Field 8—ENGINEERING WORKS

### Group 8I—Fisheries Engineering

**MYKISS, AND BROWN TROUT, SALMO TRUTTA F. FARIO.**  
Munich Univ. (Germany, F.R.). Zoologisches Inst.  
For primary bibliographic entry see Field 5C.  
W91-01959

**ACUTE TOXICITIES AND HEMATOLOGICAL EFFECTS OF TWO SUBSTITUTED NAPHTHO-QUINONES IN CHANNEL CATFISH.**  
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.  
For primary bibliographic entry see Field 5C.  
W91-01970

### 9. MANPOWER, GRANTS AND FACILITIES

#### 9A. Education (Extramural)

**PRIMER ON CLOTHING SYSTEMS FOR COLD-WEATHER FIELD WORK.**  
Geological Survey, Bow, NH. Water Resources Div.  
For primary bibliographic entry see Field 7B.  
W91-01846

#### 9D. Grants, Contracts, and Research Act Allotments

**ANNUAL PROGRAM REPORT - 1989 (FY 1988), (MASSACHUSETTS WATER RESOURCES RESEARCH CENTER).**  
Massachusetts Univ., Amherst. Water Resources Research Center.  
P. J. Godfrey.  
Available from National Technical Information Service, Springfield, VA 22161 as PB90-217217/AS. Price codes: A03 in paper copy, A01 in microfiche. Report No. G-1568-01, March 1990. 38p. USGS Contract No. 14-08-0001-G1568. USGS Project no. G1568-01.

Descriptors: \*Information transfer, \*Massachusetts, \*Research, \*Training, \*Water resources Institutes, Education, Projects.

Research on water related issues was supported by federal, state, and other funds. Projects included Denitrification System for On-Site Wastewater Treatment, Acidity and Chemistry of Clouds and Fog in Central Massachusetts, Development of a Water-Supply Decision-Making Model Incorporat-

ing the Long-Run Cost of Water, the Acid Rain Monitoring Project (A.R.M.), Phase II, Stimulation of Mercury Methylation by Acid Deposition, and Surface Water Supplies at Risk to Acid Deposition in Massachusetts—Development of a Geographic Information System Layer. Information transfer, student training, and coordination of research with various academic departments, colleges, and universities, and state, local and federal government agencies and officials continued as part of the Water Resources Institute Program. (USGS)  
W91-01860

### 10. SCIENTIFIC AND TECHNICAL INFORMATION

#### 10C. Secondary Publication And Distribution

**EVALUATION OF THREE ELECTRONIC REPORT PROCESSING SYSTEMS FOR PREPARING HYDROLOGIC REPORTS OF THE U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION.**

Geological Survey, Reston, VA. Water Resources Div.  
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Open-File Report 89-576, 1990. 66p, 27 fig, 11 tab, 19 ref. G. J. Stiltner, Editor.

Descriptors: \*Automation, \*Computer programs, \*Publications, Page layout, Software.

In 1987, the Water Resources Division of the U.S. Geological Survey undertook three pilot projects to evaluate electronic report processing systems as a means to improve the quality and timeliness of reports pertaining to water resources investigations. The three projects selected for study included the use of the following configuration of software and hardware: Ventura Publisher software on an IBM model AT personal computer, PageMaker software on a Macintosh computer, and FrameMaker software on a Sun Microsystems workstation. The following assessment criteria were to be addressed in the pilot studies: The combined use of text, tables, and graphics; analysis of time; ease of learning; compatibility with the existing minicomputer system; and technical limitations. It was considered essential that the camera-ready copy produced be in a format suitable for publication. Visual improvement alone was not a consideration.

This report consolidates and summarizes the findings of the electronic report processing pilot projects. Text and table files originating on the existing minicomputer system were successfully transformed to the electronic report processing systems in American Standard Code for Information Interchange (ASCII) format. Graphics prepared using a proprietary graphics software package were transferred to all the electronic report processing software through the use of Computer Graphic Metafiles. Graphics from other sources were entered into the systems by scanning paper images. Comparative analysis of time needed to process text and tables by the electronic report processing systems and by conventional methods indicated that, although more time is invested in creating the original page composition for an electronically processed report, substantial time is saved in producing subsequent reports because the format can be stored and re-used by electronic means as a template. Because of the more compact page layouts, costs of printing the reports were 15% to 25% less than costs of printing the reports prepared by conventional methods. Because the largest report workload in the offices conducting water resources investigations is preparation of Water-Resources Investigations Reports, Open-File Reports, and annual State Data Reports, the pilot studies only involved these projects. (USGS)  
W91-01832

**U.S. GEOLOGICAL SURVEY NATIONAL COMPUTER TECHNOLOGY MEETING: PROGRAM AND ABSTRACTS, MAY 7-11, 1990.**  
Geological Survey, Nashville, TN. Water Resources Div.  
For primary bibliographic entry see Field 7C.  
W91-01848

#### 10F. Preparation Of Reviews

**EFFECTS OF LAKE ACIDIFICATION ON AQUATIC MACROPHYTES--A REVIEW.**  
Imperial Coll. at Silwood Park, Sunninghill (England). Dept. of Biology.  
For primary bibliographic entry see Field 5C.  
W91-01105

**GROUNDWATER: A REVIEW OF THE 1989 LITERATURE.**  
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.  
For primary bibliographic entry see Field 2F.  
W91-01178

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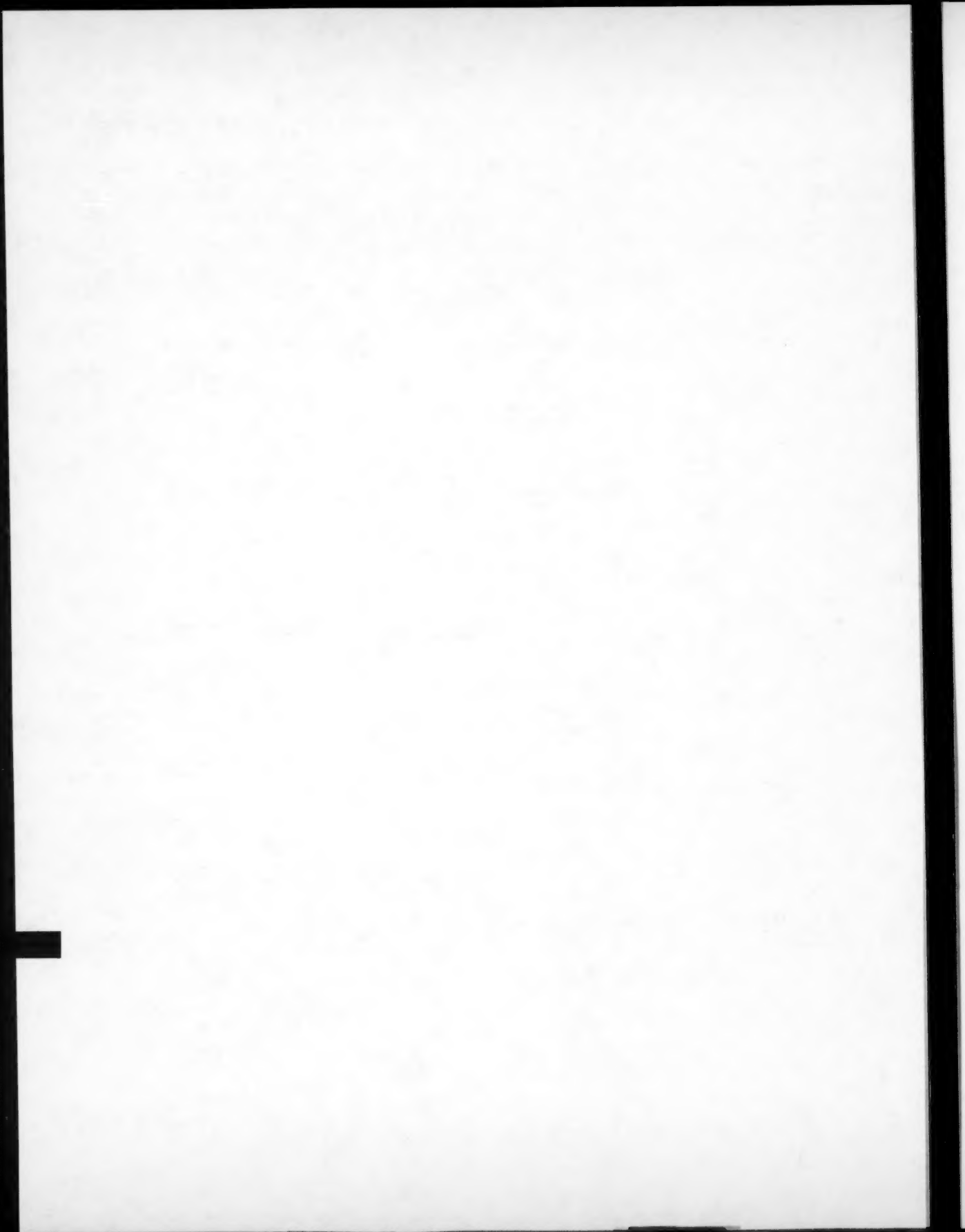
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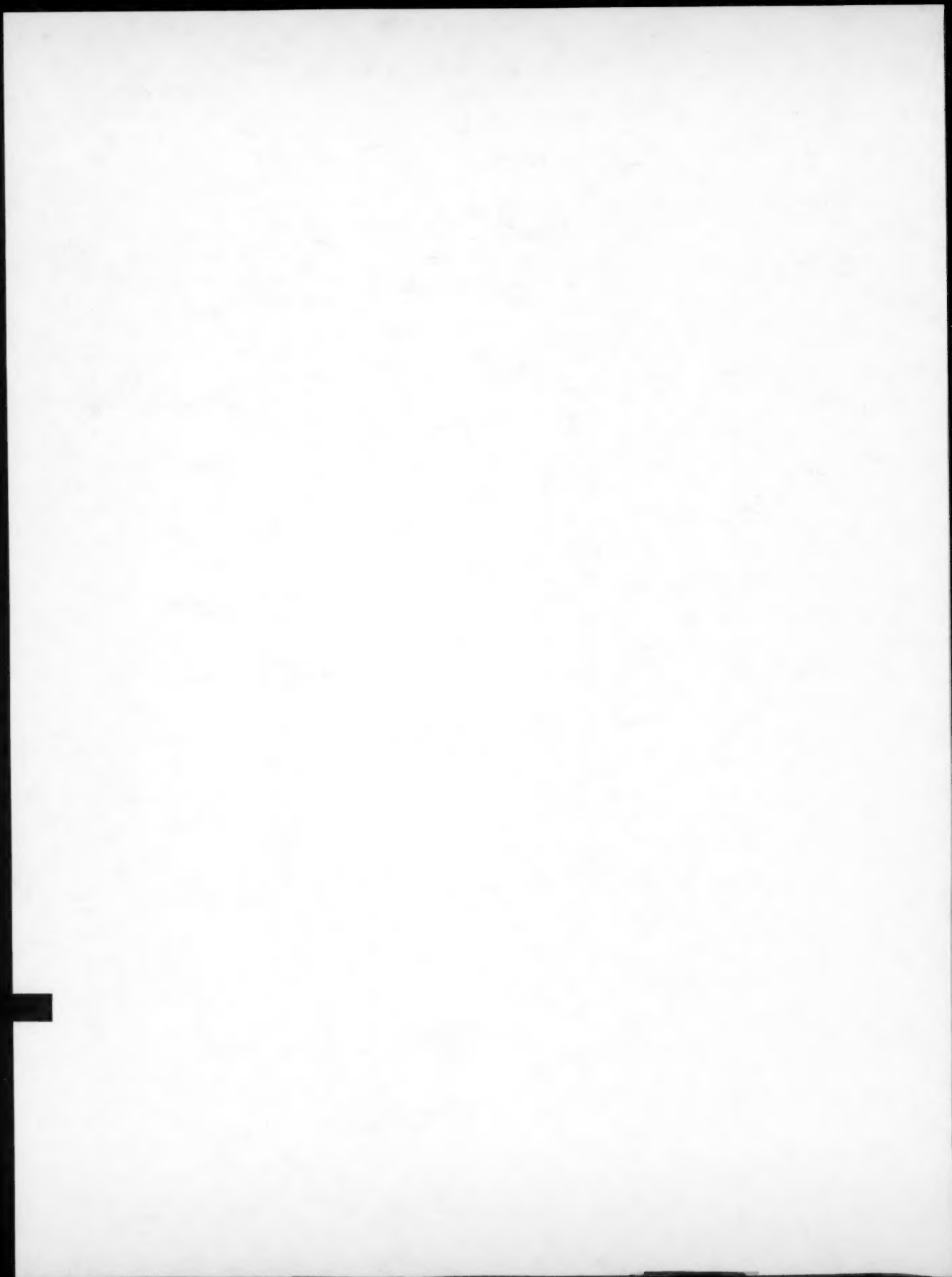
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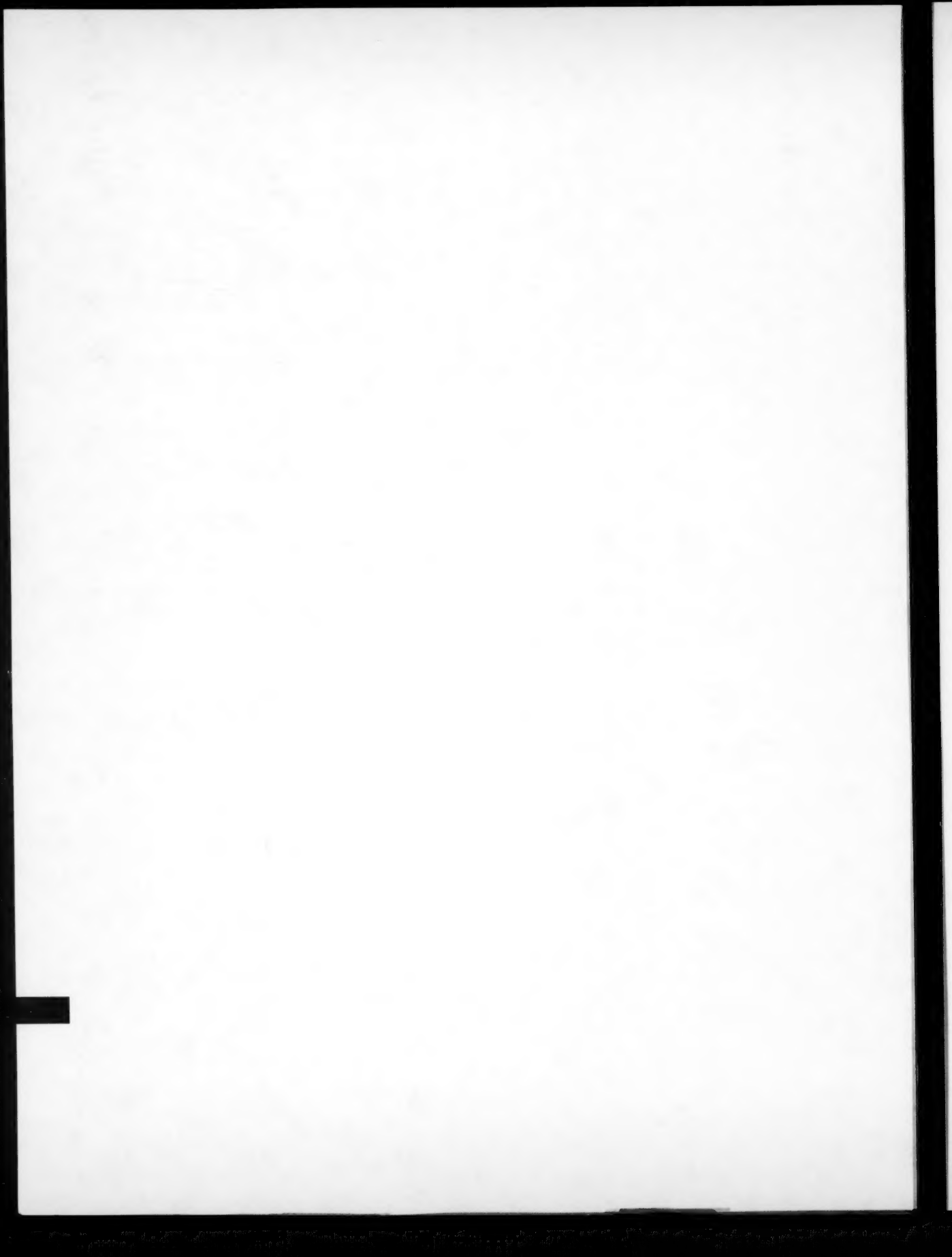
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**1991 Price Schedules for the United States, Canada, and Mexico**

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

**Microfiche & Paper Copy Reports      Computer Products**

Standard Prices	Exception Prices	Diskettes	Magnetic Tapes
A01 ..... \$8.00	E01 ..... \$10.00	D01 ..... \$50	T01 ..... \$165
A02 ..... 11.00	E02 ..... 12.00	D02 ..... 80	T02 ..... 220
A03 ..... 15.00	E03 ..... 14.00	D03 ..... 130	T03 ..... 340
A04-A05 ..... 17.00	E04 ..... 16.50	D04 ..... 180	T04 ..... 450
A06-A09 ..... 23.00	E05 ..... 18.50	D05 ..... 230	T05 ..... 560
A10-A13 ..... 31.00	E06 ..... 21.50	D06 ..... 280	T06 ..... 670
A14-A17 ..... 39.00	E07 ..... 24.00	D07 ..... 330	T07 ..... 780
A18-A21 ..... 45.00	E08 ..... 27.00	D08 ..... 380	T08 ..... 890
A22-A25 ..... 53.00	E09 ..... 29.50	D09 ..... 430	T09 ..... 1,000
A99 .....	E10 ..... 32.50	D10 ..... 480	T10 ..... 1,110
	E11 ..... 35.00	D11 ..... 530	T11 ..... 1,220
	E12 ..... 38.50	D12 ..... 580	T12 ..... 1,330
"N" Codes	E13 ..... 41.00	D13 ..... 630	T13 ..... 1,440
N01 ..... \$60.00	E14 ..... 45.00	D14 ..... 680	T14 ..... 1,550
N02 ..... 59.00	E15 ..... 48.50	D15 ..... 730	T15 ..... 1,660
N03 ..... 20.00	E16 ..... 53.00	D16 ..... 780	T16 ..... 1,770
	E17 ..... 57.50	D17 ..... 830	T17 ..... 1,880
	E18 ..... 62.00	D18 ..... 880	T18 ..... 1,990
	E19 ..... 69.00	D19 ..... 930	T19 ..... 2,100
	E20 ..... 80.00	D99 .....	T99 .....
	E99 .....		

\* Contact NTIS for price

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